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Commercialization of Agricultural Research and Biotechnology Stakeholder Consultation Workshops

Final Report

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ACRONYMS

AHPND	Acute Hepato-Pancreatic Necrosis Disease
APSU	Agricultural Policy Support Unit
AWD	Alternate Wetting and Drying
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BCC	Biosafety Core Committee
BDT	Bangladeshi Taka
BFRI	Bangladesh Fisheries Research Institute
BINA	Bangladesh Institute of Nuclear Agriculture
BLRI	Bangladesh Livestock Research Institute
BRRRI	Bangladesh Rice Research Institute
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
CDB	Cotton Development Board
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
DAE	Department of Agricultural Extension
DLO	District Livestock Officer
DLS	Department of Livestock Services
DoF	Department of Fisheries
EWG	Expert Working Group
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
FSB	Fruit and Shoot Borer
GE	Genetically Engineered
GOB	Government of Bangladesh
GR-1	Golden Rice First Generation
GR-2	Golden Rice Second Generation
IBC	Institutional Biosafety Committee
IFPRI	International Food Policy Research Institute
JUST	Jashore University for Science and Technology
Kg	Kilogram
LSD	Lumpy Skin Disease
MCC	Multi-Colored Chicken
MoA	Ministry of Agriculture
MoEF	Ministry of Environment, Forests and Climate Change
MT	Metric Ton
NCB	National Committee on Biosafety
NGO	Non-Governmental Organization
NTCCB	National Technical Committee on Crop Biotechnology
PG	Pituitary Gland
PRSSP	Policy Research and Strategy Support Program

RARS	Regional Agricultural Research Station
RCC	Red Chittagong Cattle
RDC	Rice and Diversified Crops
RFS	Bureau for Resilience and Food Security
SDG	Sustainable Development Goal
SHISUK	Shikha Shastha Unnayan Karzakram
SME	Small and Medium Enterprise
SRDI	Soil Resource Department Institute
SUFO	Senior Upazila Fisheries Officer
UAF	United Agro Fisheries
UAO	Upazila Agriculture Officer
ULO	Upazila Livestock Officer
USAID	U.S. Agency for International Development
WSSV	White Spot Syndrome Virus
ZOI	Zone of Influence
ZOR	Zone of Resilience

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EXECUTIVE SUMMARY

From December 6-10, 2020, USAID organized and IFPRI facilitated five virtual stakeholder consultation workshops on agricultural research and biotechnology, bringing together relevant stakeholders involved in crop and non-crop agriculture from Barishal, Cox's Bazar, Dhaka, Jashore, and Khulna districts in southern Bangladesh. This format aimed to capture the views and perceptions of a range of relevant actors on the status, opportunities and challenges, and recommendations for improving agricultural research and biotechnology.

This report presents the subjective views of participants who are affected by and have a stake in these discussions, from value chain actors who have had challenges cultivating certain varieties and raising certain breeds due to climate-related challenges to researchers who are developing new varieties and breeds accounting for these ground-level challenges. Although the authors have substantiated parts of this report with primary and secondary data sources, the major thrust of this report is to communicate perspectives as they were framed during the workshops. Although stakeholder responses reflect varying knowledge levels of biotechnology among participants, some of which may be convoluted or inaccurate, this report preserves the diversity of stakeholder input as an honest reflection of the opinions received.

Although there are unique, context-specific challenges that were identified across districts, there were several recurring themes. There was a general consensus that agricultural research and biotechnology, however broadly defined, are important for addressing emerging challenges, particularly in the wake of increasing frequency and severity of weather-related hazards and natural disasters. To this end, tackling agricultural production problems requires developing new, innovative technologies. National agricultural research systems, including Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI), Bangladesh Livestock Research Institute (BLRI), and Bangladesh Fisheries Research Institute (BFRI), to name a few, have various varieties and breeds in the pipeline for development, yet despite these ongoing efforts, agricultural production patterns remain relatively unchanged in Bangladesh. Many farmers continue to cultivate outdated varieties—particularly rice, despite not being as profitable or climate-resilient.

Furthermore, participants identified a supply-demand gap for various varieties and breeds. For example, there was a resounding call for greater availability of short-duration varieties, which can be accommodated within the cropping pattern and improves the chances of being harvested before crops can be damaged. Development and adoption of *appropriate* varieties is critical considering that the total cultivable land in Bangladesh cannot expand. Participants recommended further research on crop zoning to determine which crops should be cultivated where, as a way to increase cropping intensity.

Similarly, farmers' views of Bt brinjal cultivation were mostly positive, generally earning a higher profit than local varieties and being less susceptible to fruit and shoot borer (FSB) infestation, yet most producers stated there is insufficient seed supply inhibiting their production decisions. Other farmers reported positive experiences cultivating certain rice varieties, but were deterred from pursuing these further as consumers prefer thicker rice grains or the rice remains firm when it is cooked. Unique to biotech crops, participants across the workshops recommended that improved labelling would improve visibility of the products, consumer awareness, and

transparency. In sum, research and development must account for the entire food value chain to improve varietal and breed adoption and market acceptance.

Despite the prevailing supply-demand gaps affecting various varieties and breeds, participants acknowledged that there was limited private sector involvement in developing genetically engineered varieties or multiplying certain crops. During the workshops, this was attributed to either lack of interest among the private sector or lack of meaningful collaboration with government research agencies.

During the workshops, many farmers reported lacking access to high quality agricultural inputs, including low-cost hybrid seeds, animal feed, bio-pesticides, fertilizers, and so on—a claim supported by numerous attending local-level agricultural extension officials. Exacerbating the situation, there were reports that many agricultural input dealers take advantage of farmers' lack of awareness and limited options for recourse by hiking prices of seeds, pesticides, and other critical inputs, leading farmers to either 'pay the freight' or forgo the costs and inputs altogether and, in turn, reduce their crop or non-crop productivity. Participants suggested that Department of Agricultural Marketing (DAM) may prioritize training seed and feed dealers on how to handle and sell their agricultural inputs, as well as increased monitoring to mitigate market manipulation. Moreover, participants stressed increasing the availability of low-cost local agricultural machineries to lower labor costs; reduce reliance on agricultural labor, which can be in short-supply for certain crops; and boost agricultural productivity.

Lack of value chain development inhibits the growth of non-rice crop agriculture and non-crop agriculture like fisheries and livestock, most of which rely on packaging, storage, transport, and other services to maintain the market quality of their products or enable a product to be export-ready. During the consultations, various crops, livestock breeds, and fish varieties were discussed as having potential in the region—watermelon, seaweed, dried fish, various types of flowers, and so on—yet farmers lack the proper training on how to preserve these products, market linkages and consumer awareness are absent, and there are insufficient systems to minimize post-harvest loss. Other products, such as cotton, face issues with inadequate labor supply, or confront challenges in the processing procedure, in line with international regulations. These 'high potential' areas will remain untapped until value chains are more developed.

Overall, agricultural research has identified various priority areas for advancing agricultural development in the country, many areas where biotechnology—either through conventional methods or otherwise—can contribute. Solutions must address the needs and demands of actors across the value chain. Broadly, there must be increased coordination and collaboration among the public and private sector, which can help improve availability of high quality agricultural inputs and identify domestic or international markets for agricultural goods. The research agenda underlying varietal and breed development must be client-centered, considering producers' financial incentives and consumers' preferences to improve likelihood of adoption and acceptance. In conjunction, as Bangladesh is divided into 30 agro-ecological zones, more research should be conducted on which crops should be cultivated where. As there has been relatively limited progress on agricultural diversification nationwide and in the Feed the Future Zone of Influence (ZOI), this warrants more research on the drivers of production decisions and how to diversify production in the respective geographic areas. The respective agricultural extension agencies of crop, livestock, and fisheries should also train farmers on production fundamentals: proper feeding methods; optimal utilization of agricultural inputs,

including for biotech crops; maintenance of crops, livestock, or fisheries (e.g., how to treat disease or infestation); and other troubleshooting support on an ongoing basis.

This report makes an ambitious attempt to capture an array of insights on the vast area of commercializing agricultural research and biotechnology. This summary provides a high altitude perspective of the challenges and opportunities in this arena. To complement, there is a dedicated chapter for all five district workshops in this report, each of which closes with salient points at the district-level. Furthermore, the conclusion of the report (Section 7) provides a more comprehensive deep dive into the challenges and recommendations emanating from the stakeholder consultation discussions, outlined by agricultural sector.

1 INTRODUCTION

1.1 Overview of Stakeholder Consultation Workshops

On September 18, 2020, USAID requested IFPRI to conduct 15 stakeholder consultations on three thematic areas across five districts in the Feed the Future Zone of Influence (ZOI) and Zone of Resilience (ZOR): Barishal, Cox’s Bazar, Dhaka, Jashore, and Khulna. The thematic areas are: (1) Increased Access to Finance, (2) Commercialization of Oilseeds and Pulses, and (3) Commercialization of Agricultural Research and Biotechnology. IFPRI agreed to conduct these stakeholder consultations and, on October 25, 2020, USAID approved IFPRI’s concept note on the Commercialization of Agricultural Research and Biotechnology thematic area (**Appendix 1**). This concept note incorporated comments from the USAID Bureau for Resilience and Food Security (RFS).

1.2 Program Format and Participation

The Commercialization of Agricultural Research and Biotechnology virtual stakeholder consultation workshops were conducted from December 6-10, 2020, co-moderated by Dr. A.S.M. Mahbubur Rahman Khan, Dr. Nasreen Sultana, Mr. Rezaul Karim Siddique, and Mr. Subrata Kumar Kundu.

Each of the five Commercialization of Agricultural Research and Biotechnology stakeholder consultation workshops was approximately two hours long. **Table 1.1** provides the workshop agenda, which includes a briefing on the Zoom technical functionalities (e.g., mute, raise hand, using the chat box), followed by welcome remarks, an overview presentation by the technical moderators, breakout sessions, and concluding remarks from the technical moderators. **Appendix 2** provides the designed workshop agenda that was projected during the workshops.

Table 1.1 Commercialization of Agricultural Research and Biotechnology workshop agenda

Time (BDT)		Topics
9:20	9:35	Introduction to Zoom Functionalities
9:35	9:40	Welcome/Introductory Remarks by USAID and IFPRI
9:40	9:48	Overview Presentation and Objectives of the Consultation
9:50	11:25	Discussion with Stakeholders [Breakout Room Format]
11:25	11:30	Concluding Remarks

Between October and November 2020, IFPRI and Feed the Future activities nominated potential stakeholders who met the following criteria: (1) were familiar or involved with agricultural research and/or biotechnology, (2) interested and available to participate, (3) had sufficient digital literacy to participate effectively in a Zoom consultation, and (4) were working in one of the five districts (either based in the district or remotely).

Table 1.2 presents the number of total participants for the Commercialization of Agricultural Research and Biotechnology stakeholder consultation workshops, by the 10 stakeholder categories proposed by USAID and by district. **Appendix 1** features the Bangla and English invitation letters that were sent to the nominated stakeholders.

Table 1.2 Commercialization of Agricultural Research and Biotechnology district workshop participation, by stakeholder category

Stakeholder Categories	District Workshops					Total
	Barishal	Cox's Bazar	Dhaka	Jashore	Khulna	
Academia	0	1	0	0	0	1
Value Chain Actors	20	9	6	14	26	75
CSOs	0	0	0	0	0	0
Donor/Donor-Funded Activities	8	7	15	10	8	48
Government	26	18	41	23	36	144
Judiciary	0	0	0	0	0	0
Media	0	0	1	0	0	1
NGOs	9	3	7	7	7	33
Private Sector	0	2	18	7	4	31
Financial Institutions	1	1	0	0	0	2
Total	64	41	88	61	81	335

1.3 Organization of Report

This report is organized into seven sections. Section 1 presents the objectives of the stakeholder consultation workshops, the program format and participation by district and overall, and the structure of this report. Given the geographic differences in agricultural research and biotechnology across the five districts of interest, Sections 2 through 6 present a comprehensive overview of the discussions from Barishal, Cox's Bazar, Dhaka, Jashore, and Khulna to ensure that the challenges, opportunities, and recommendations in each district are adequately captured. Section 7 concludes with the salient findings and recommendations.

Please note that this report presents the discussions from the workshops as they took place. The authors have sought to remain objective in presenting this information. As such, this output is a consultation workshop proceeding, and is *not* meant to represent a research output.

Participant names have been excluded from the report to protect the confidentiality of participants; instead, organizations and designations are presented to convey the participants' perspectives.

2 BARISHAL DISTRICT

On December 6, 2020, USAID organized and IFPRI facilitated the Commercialization of Agricultural Research and Biotechnology, stakeholder consultation workshop to glean insights from representatives on the status, opportunities and challenges, and recommendations related to the commercialization of agricultural research and biotechnology in Barishal.

2.1 Perspectives from Government

Part of the Barishal workshop focused on understanding the priorities of the national research institutions—including but not limited to the Bangladesh Rice Research Institute (BRRI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Agricultural Research Institute (BARI)—and the challenges of conducting agricultural research.

The Chief Scientific Officer, BRRI, Barishal discussed research on Golden Rice—a genetically engineered, biofortified crop developed to reduce vitamin A deficiencies. Research on Golden Rice first generation (GR-1) was initiated in 2005. The second generation of Golden Rice (GR-2) has completed laboratory, greenhouse, and confined field trials in different parts of Barishal, and the performance was satisfactory. It is now awaiting biosafety approval and regulatory clearance. In addition to Golden Rice, BRRI has made significant progress in developing various climate-resilient varieties. The varieties presented by this BRRI representative and a subsequent BINA representative are summarized in **Table 2.1**. Despite this progress, the Chief Scientific Officer stated that there is still a need to develop and release improved, climate-resilient varieties that have a taller seedling height and better submergence capacity.

Currently, BRRI supplies breeder seeds to the Bangladesh Agricultural Development Corporation (BADC) NGOs, and seed breeding companies via a list of more than 500 partners. BRRI also produces a smaller proportion of seeds for the farmers and demonstrations, and are applying several marketing strategies to aid in the commercialization of the hybrid seeds.

Table 2.1 Varieties presented by select BARI and BINA participants

Specialty	Varieties	More Information*
Submergence-tolerant	<i>BRRI Dhan 51, BRRI Dhan 52, Bina Dhan 11</i>	N/A
<i>Saline-tolerant</i>	<i>BRRI Dhan 47, 61, and 67</i>	<i>BRRI Dhan 67</i> is especially popular and performs well in high salinity and normal conditions
<i>Short-duration</i>	<i>BRRI Dhan 76 and 77</i>	To counter flooding issues due to tidal waves, BRRI has released these varieties. The seedling heights of these two varieties are taller and have similar yield as locally-used varieties, but offer a shorter-duration for growth and harvest
<i>Zinc-enriched</i>	<i>BRRI Dhan 62, BRRI Dhan 64, BRRI Dhan 74, BRRI Dhan 84, Bina Dhan 20</i>	<i>BRRI Dhan 64</i> matures in 100 days, yet is not popular in Barishal since it is not saline-tolerant. <i>BRRI Dhan 74</i> gives a high yield, has taller seedlings, is more stress-resilient, and has high amylose content.
	<i>BRRI Dhan 97 and 99</i>	Recently, BRRI has released <i>BRRI Dhan 97</i> and <i>99</i> , which shows promise.
<i>Short-duration, salinity-tolerant</i>	<i>Bina Dhan 10</i>	
	<i>Bina Dhan 17</i>	Green super rice cultivated in highland areas

*This information was provided by two representatives from BARI and BINA during the consultation; the information included in this table is presented as it was narrated.

A BINA representative in Barishal identified cropping intensity as the main challenge in Barishal. To this end, adopting short-term crop varieties like *Bina Dhan 10* can enhance cropping intensity in the region. *BINA Dhan 10* is saline-tolerant and produces bold grains. These varieties are also included in **Table 2.1**.

Farmers tend to prefer cultivating traditional varieties; therefore, changing farmers' production practices to cultivate new, advanced, stress-resilient varieties requires concerted efforts. Additionally, farmers should alter their current cropping pattern into a triple cropping pattern. To accomplish this, BINA is supplying seeds to gradually alter farmers' cropping patterns.

A BARI representative identified seed availability as a key issue in Barishal. For instance, various non-rice crops that are grown in Barishal, such as maize, oilseeds, and pulses, are not widely available. Additionally, various advanced hybrid varieties have been developed, but are not consistently available to farmers. Examples include *BARI Maize 13* and *BARI Maize 9*, which are popular; *BARI Sweet Potato 7*, which gives a good yield; *BARI Potatoes 72, 73, and 78*, which are resistant to heat; and *BARI Sweet Potato 4* and *8*, which are carotene-enriched. Another example is *BARI Mungbean 6*, which the Bangladesh Agricultural Development Corporation (BADC) distributed to farmers, but seed production is insufficient. Currently, BADC, DAE, and BARI cannot keep up with farmers' demand. Furthermore, although there are private seed companies that supply seeds to farmers, even the private sector is not adequately filling

this supply-demand gap in the district. Participants recommended that private sector and NGOs should complement the public sector by multiplying these hybrid seeds and fill the gaps to ensure that high quality seeds are available to farmers.

BARI distributed Bt brinjal seeds to southern regions of Bangladesh, such as Patuakhali, Amtali, and Dumki upazilas. This variety has been very well-received by farmers, as it is pest-resistant, and has high market demand because Bt brinjal remains fresh longer compared with local varieties. However, there have been some challenges regarding *Bt Brinjal 2*: sometimes its color fades, tastes bitter, and is comparatively smaller in size.

A BARI Chief Scientific Officer in Barishal asserted that due to the environment in Barishal, it takes time for a seed to sprout. The representative stated that BARI had supplied 82 kg of Bt brinjal seeds in 11 upazilas, and there is still more demand for it. Another BARI colleague reinforced that Bt brinjal is especially popular in Bhola and Patuakhali upazilas. The BARI researchers in Barishal collect these seeds from the BARI Headquarters and produce it at their field station, which is then distributed to the farmers. Additionally, farmers can produce their seeds as it is an open-pollinated plant. There are some private companies interested in multiplying Bt brinjal seeds, but he has not heard of any private companies actually multiplying them.

A BARI Scientific Officer stated that he works with crop toxicity and their solutions. “Nowadays, many new insects and diseases are emerging due to climate change,” he said. One example is the whitefly infesting coconuts, which destroys the fruit. BARI has identified 15 such insects and disease issues, which are commonly found in coconuts, betel leaf, mungbeans, areca nut, and hog plums. Given this, research is needed on ways to minimize infestation via gene-editing, similar to what has been achieved in the development of Bt brinjal.

Despite advancements in research, these research findings are not always trickling down to the field-level to benefit farmers. The BARI Scientific Officer stated, “Seed production is sub-optimal, bio-pesticides are not easily available, farmers are not aware of the benefits of using the bio-pesticides, and the relatively high prices of pesticides and seeds are undercutting farmers’ access to these critical inputs.” Although many bio-pesticides that were not previously registered in Bangladesh are now more widely available, farmers are often manipulated by dealers to buy expensive products or use pesticides that are not needed.

BADC’s Deputy Director of Seed Marketing stated that Barishal is agronomically diverse, has unique cropping patterns, and faces unique challenges that undercut agricultural productivity. “Land salinity is not the main issue in Barishal: tidal flood is,” he stressed. Normally, BRRI rice crop takes one month to sprout in Barishal, but it takes 10 days with the use of lake water. Since cropping patterns vary across Barishal, this makes it more challenging to distribute hybrid seeds to farmers uniformly. Therefore, he urged the DAE to play an active role in distributing these varieties to producers in high-potential areas.

Barishal is affected by waterlogging. Several government projects on water management are being implemented, but participants state that these initiatives are largely uncoordinated. A BARI representative recommended further research on the use of a surgical drainage system, as well as on specialized cropping patterns for different regions with different agronomic characteristics. A proper irrigation system also needs to be built, in coordination with different departments, and community farming should be encouraged.

The DAE Deputy Director stated that the main crops in the region are rice, and various oilseeds and pulses are secondary. “*BRRRI Dhan 76* and *77* are popular species in areas that are affected by tidal wave because they grow tall over the ground. *BRRRI Dhan 47, 67, and 74* are saline-tolerant species, all of which are popularly cultivated in Barishal. For oilseeds and pulses, *BARI Mustard 14, 15, 18*, along with *Bina Mustard 4* and *9*, are suitable choices. For pulses, there is *Mungbean 6*,” he said. Tidal waves, natural disasters, and climate change still present significant challenges in these areas. Thus, short-duration, submergence-tolerant species for rice, oilseeds, and pulses are required.

The available biofortified varieties that are being marketed include *BRRRI Dhan62*, which is a zinc-enriched variety, as well as *BINA Dhan 20* and *BRRRI Dhan 74*. These seeds are provided in adequate amounts by BADC, BARI, and small- and medium-sized enterprises (SME) seed providers created by a government subsidized program; however, some hybrid seeds like maize, which have good potential in the region, are not available in the region or the cost of these hybrid seeds is too much when produced by the private sector. Government support in providing these costly hybrid seeds to farmers would be beneficial.

A representative from BARI in Bhola stated that the cropping pattern in this district is centered on vegetables, such as onions, cauliflower, tomatoes, pumpkins, and so on. Bt brinjal has been well-received in Bhola, and some farmers sell Bt brinjal in Dhaka at a good market price. However, most Bt brinjal farmers in Bhola do not have enough seeds since BADC does not produce these seeds. Furthermore, there is no BADC office in Bhola. Thus, they have to collect necessary seeds from the main city of Barishal. Nevertheless, the BARI representative opines that Bt brinjal has great potential in Bhola because it helps inhibit crop loss due to infestation. Farmers can sell all of the Bt brinjal harvest, which makes them more inclined to cultivate this variety.

The DAE Deputy Director for Pirojpur stated that he supplies stress-tolerant *BRRRI Dhan 52*, zinc-enriched *BRRRI Dhan 74*, and promotes Bt brinjal in his district. To promote and commercialize these varieties, he conducted farmer demonstrations and distributed 15 kilograms (kg) of Bt brinjal seeds to farmers. Bt brinjal was already in demand but the seed production was insufficient to meet farmers’ demand. He advised big seed companies like Supreme Seeds, Metal Seeds, and similar organizations to intervene to increase seed availability.

The DAE Deputy Director of Pirojpur stated that 30,000-35,000 hectares of cultivable land remains fallow every year due to climate change and the late Aman harvest. Currently, the DAE is trying to introduce sunflowers, oilseeds, pulses, and maize to fill this gap. The introduction of short-duration and submergence-tolerant varieties would also assist in filling this gap.

The BADC Deputy Director from Barishal stated that the farmers are gradually adopting new genetically engineered crops and stress-tolerant varieties. To speed up this process, he advised dealer networks, BADC, and DAE to collaborate in encouraging and informing farmers of the benefits of these new varieties. Also, most farmers’ production decisions are motivated most by the commercial aspects of what they grow (e.g., market price, production cost, final yield). Therefore, any effort to increase adoption of new varieties should account for the profitability of these crops. The representative stressed that the consumers must know about the varieties to enhance market awareness and acceptance. Most Bangladeshis consume rice and are

reluctant to eat vegetables. “If rice can give all the nutrients and vitamins, then more nutritious varieties of rice should be brought to the market fast,” he said.

The Deputy Research Director from the Agricultural Policy Support Unit (APSU) of the Ministry of Agriculture (MoA) suggested that new hybrid varieties of rice *and* vegetables are needed if the nation wants to reach the Sustainable Development Goal (SDG) target of ending all forms of hunger and malnutrition by 2030. He added that the taste and features of rice cannot be neglected because these features drive consumer preferences.

2.2 Perspectives from Agricultural Value Chain Actors

A farmer from Barishal said that he cultivates *BRRRI Dhan 28, 47, 66, and 74*. Among these, *BRRRI Dhan 74* is a short-duration variety, which reduces the risk of submergence. However, when this rice is cooked, it becomes a little soft after some time. Therefore, although this farmer reports that *BRRRI Dhan74* has high yield, he has trouble selling it in the market compared with other rice varieties because of this issue after cooking.

A different farmer cultivates *BINA 10, 28, and 29*. *BINA 10* and *28* have lower yields than *BINA 29*, but *BINA 28* matures fast, which is why it is popular as it can avoid climate-related issues like submergence. He suggested that if the ‘soft rice’ issue can be solved and proper awareness on the zinc content in rice can be raised, then the market demand for this rice can increase.

Another farmer cultivates *BRRRI Dhan 11, 56, and 41*, which are all hybrid rice species. Although these bring relatively high yields, sometimes insects destroy a portion of the crops. The farmer does not know of any newer varieties, which are more nutritious and give higher yields. If he knew about Bt brinjal and the biofortified crops, he would have cultivated them instead.

A different farmer cultivates Bt brinjal. He stated that BARI *Bt Brinjal 1* is smaller in size and BARI *Bt Brinjal 2* tastes a little bitter, but BARI *Bt Brinjal-4* looks appealing, the size and yield are good, and there is no insect infestation.

A Bt brinjal farmer in Barishal asserted that the yield from Bt brinjal is good. Even though it is small in size, there is no pest infestation. Thus, he can utilize all of his crops, whereas 20-30 percent of the yield from local varieties is usually destroyed by pests. During the workshop, the farmer stated, “Some farmers adopted Bt brinjal after seeing me. The market price is good and the bitter taste complaints have diminished,” he added. He consumes the Bt brinjal and will continue to cultivate it if more open-pollinated, HYV seeds like these are provided. If the crop is not infested, then he does not need to use pesticides and the harvest remains organic. In such cases, both customers and farmers are attracted to such crops.

Another farmer cultivates BARI *Bt Brinjal 4* and testified that its yield is good and other farmers are also interested in cultivating this variety. However, the seeds are not available. He collected the seeds from the agricultural office and suggested that if the seeds were available earlier, he would have gotten a better price. This year, *BRRRI Dhan 73, 74, and 34* were brought to his area for testing and demonstrations. The plants were taller, submergence-tolerant, and the yield was estimated to be high, but a flood destroyed the crops. Nevertheless, the farmers from this participant’s area are still interested in cultivating Bt brinjal.

An input dealer from Barishal said that 60 percent of the seed that he sold this year is the zinc-enriched *BRRRI Dhan 74*, which is quickly replacing *BRRRI Dhan 47*. He also stressed the need for short-duration oilseeds and pulses. He said that Bt brinjal does not have much presence in

the market yet, but has potential as it addresses the biggest threat of brinjal cultivation—pest infestation. He noted that farmers are not willing to cultivate new varieties easily. However, if more awareness is created and the farmers learn about Bt brinjal’s advantages, then its demand could increase further.

An input dealer shared that he sells seeds for *BRRRI Dhan 28, 29, and 52*. *BRRRI Dhan 52* is especially popular as its seedling is tolerant to waterlogging. He also sells the newer gene-fortified hybrids but the farmers are more inclined to continue cultivating the traditional varieties. However, he tries his best to convince them of using newer hybrid varieties. He confirmed that modern hybrid/GE varieties like golden rice will sell well if introduced to his area as long as the small seed providers and the DAE officials promote it.

2.3 Perspectives from the Private Sector and NGOs

A representative from the USAID-funded Rice and Diversified Crops (RDC) activity implemented by ACDI/VOCA provided several discrete recommendations. First, he asserted that there is a need for cluster-based cropping research in Barishal. Second, further research should be done on developing a single-skinned black sesame variety, which has international demand. Third, climate change is resulting in rapidly evolving, unpredictable weather-related hazards that can damage crops; therefore, short-duration crop varieties are needed. For example, in Barishal, further research can be invested in developing a mungbean variety that can be harvested in two turns instead of three. Lastly, although maize hybrid varieties have potential in the region, the seeds are not available.

The Executive Director of SAINT Bangladesh stated that farmers are still not using several of the hybrid crop varieties, and the sluice gates that control the water flow of the lakes in Barishal have negatively affected some farmers.

2.4 Concluding Findings

The virtual stakeholder consultation workshop gleaned key insights on the status, challenges and opportunities, and ways forward for commercializing agricultural research and biotechnology in Barishal district. Select points are highlighted below:

- Tidal floods and water stagnation are key problems faced by farmers in the region.
- Private sector participation is almost non-existent for biofortified and genetically engineered crops, yet private sector involvement could assist with filling gaps in seed availability.
- There are many hybrid rice varieties that are popular in Barishal, especially zinc-enriched rice. Key steps towards commercializing zinc rice include arranging demonstration plots, supplying inputs to farmers at no cost (including seeds), and organizing farmers’ field days. HarvestPlus has also been successful at commercializing zinc rice by raising producer and consumer awareness of the new variety.
- Some farmers reported benefitting from Bt brinjal cultivation. Hybrid seeds for crops like oilseeds and pulses are not available.
- Prioritize the development and release of short-duration and climate-resilient varieties due to frequent, unpredictable weather-related issues that damage crops in Barishal.
- Land should be categorized by different topographies (e.g., low-, mid-, mid-high, and high-levels), which may guide the implementation of specialized cropping patterns, in coordination with DAE, BADC, SRDI and other relevant agencies.

- Conduct further research on developing a zinc rice variety that does not become soft when cooked.
- There are reports of input dealers and other traders that are misleading and manipulating farmers, causing them to purchase pesticides that they do not need or are not appropriate for their issue. Necessary training for farmers and traders is suggested to tackle this issue, as well as strengthened market monitoring.
- The government and the private sector must collaborate to commercialize agricultural research and bio-technological products.
- For seed varieties, bold seeds, tall plants, submergence-tolerant, and stress-tolerant varieties are needed due to the climate of these areas are frequently visited by storms, cyclones, floods, and so on.

3 COX'S BAZAR DISTRICT

On December 7, 2020, USAID organized and IFPRI facilitated a stakeholder consultation to glean insights from representatives on the status, opportunities and challenges, and recommendations related to the commercialization of agricultural research and biotechnology in Cox's Bazar.

3.1 Perspectives from Government

Various representatives from BARI, BIRRI, BINA, and other government agencies discussed the status of agricultural research and biotechnology, challenges and opportunities, and ways forward in the southeastern district. Representatives from these government agencies, in particular, discussed the contributions of national agricultural research institutes in Cox's Bazar towards developing and releasing modern crop varieties that address issues afflicting farmers and consumers.

A BARI representative shared that all four Bt brinjal varieties have undergone field-level trials. *Bt Brinjal 2* and *4* have shown higher yields and the farmers preferred BARI *Bt Brinjal 4*. The representative identified two challenges with Bt brinjal cultivation in Cox's Bazar: (1) yield decreases during the summer season, and (2) although the crop is resistant to fruit and shoot borer (FSB), there are still other pests that need to be repelled. On a related note, the BARI representative mentioned that although genetically engineered tomatoes would be beneficial in Cox's Bazar, he has yet to receive any biofortified or genetically engineered tomato crop that is disease-resistant.

Another BARI representative discussed the commercialization and production of Bt brinjal. He stated that BARI *Bt Brinjal 1, 2, and 3* are doing well in specific locations. BARI *Bt Brinjal 4* has grown in popularity as it is doing well in all areas. Although Bt brinjal is a winter crop, BARI *Bt Brinjal 4* appears somewhat tolerant to summer cultivation. BARI *Bt Brinjal 10 and 11* are bacteria-resistant varieties, which will be released soon. He asserted that Cox's Bazar's weather and cropping patterns are the main barriers limiting Bt brinjal, but BADC and BARI are providing adequate seeds.

The BARI representative also identified several barriers in the agriculture sector. For example, farmers cultivate late maturation T. Aman rice varieties. If the late maturation varieties are replaced by short-duration varieties, farmers could save 15-30 days. Moreover, this saved time could be used to cultivate another crop while the fields are open for cultivation. Additionally, as a coastal area, Cox's Bazar has short winters and the region has high humidity. This makes crops more vulnerable to diseases. These conditions must be considered before introducing a genetically engineered crop to fit the cropping pattern in the area.

A representative from the Bangladesh Fisheries Research Institute (BFRI) in Cox's Bazar discussed the technologies used in fish farming and the issues that require further research. In Cox's Bazar, most fish farmers cultivate tilapia, which is currently being reared by two hatcheries. His department is researching seaweed and crab species. The crab population is decreasing; therefore, they are trying to mass produce crabs and establish crab hatcheries in Cox's Bazar. Regarding prawns, BFRI distributed prawn larva to farmers and implemented four international guidelines on prawn cultivation, which includes (1) the water must be from

reservoirs to limit fish viruses, (2) the cultivation should follow a nursery system, (3) water depth should be increased, and (4) disease-free tadpoles should be used.

Cox's Bazar is producing approximately 10,000 MT of dry fish. Many farmers are inadvertently using hazardous substances on these fish, which may lead to health issues. To counter this, BFRI is trying to raise awareness against the usage of bio-hazard substances like antibiotics. "An awareness program was conducted, which decreased the usage of bio-hazards slightly. However, strict government monitoring is necessary," he stressed. BFRI is also promoting a method, which involves 20-22-day intervals between fishing trips, which has reduced overfishing.

Seaweed production is also a growing area of interest in Cox's Bazar, mostly fueled by international demand. The seed is sourced within Bangladesh, specifically from Satkhira and Saint Martin's Island. Since 2017, BFRI has been continuously conducting seminars and demonstrations on seaweed cultivation methods. Currently, there are 50 seaweed cultivation nurseries in Cox's Bazar. The BFRI representative stated, "Seaweed is very healthy, and fishermen are using it as feed for newborn fish larva." The BFRI representative identified three main barriers related to seaweed: (1) seed availability, (2) popularization, and (3) proper market identification domestically and internationally.

BFRI is also prioritizing mrigal, seabass, and carp cultivation, particularly given their market potential. However, the challenge is identifying locations where climate change and natural disasters cannot affect the hatcheries. BFRI is involved in assessing the quality of live feed and biofortified fish eggs before distribution. Any private companies that sell substandard live feed have their products banned. Some farmers are injecting gel in prawns to make them appear larger. BFRI, NGOs, and other organizations have been raising awareness on the risks of injecting gels into prawns. Although the practice has decreased, it has not been eliminated.

A Scientific Officer from the Bangladesh Livestock Research Institute (BLRI) discussed livestock research and related issues. BLRI is responsible for conducting livestock research, whereas the Department of Livestock Service (DLS) applies the research findings at the field-level. Thus far, BLRI has introduced 17 new varieties of cattle, as well as two chicken varieties—namely, hilly chicken and Naked Neck chicken—which can be reared under a scavenging and semi-intensive scavenging system. Specifically, the hilly chicken is more resistant to diseases, can mature within 6-8 weeks, weighs about 2-3 kg, and produces 140-150 eggs a year. The market price of hilly chicken is approximately the same as regular chicken. BLRI and DLS are promoting hilly chickens, although no specific initiatives were mentioned during the stakeholder consultation.

BLRI is promoting Red Chittagong Cattle (RCC), which has lower milk producing capacity than exotic breeds (4-5 liters/cow versus 10-12 liters/cow), but also lower production costs. BLRI is promoting this local breed because it has higher milk producing capacity compared with local breeds, and its broader adaptability to more challenging contexts, including hilly, saline-affected areas. This breed is also more resistant to diseases and requires less management. The institute has also introduced Black Bengal and Brown Bengal goats, Tangail breed, and Borendo breed cattle, all of which are performing well and have been well-received by farmers. BLRI supplies eggs, semen, and young animals nationwide, but the supply does not meet the demand. He added that the farmers prefer cross-breeds. However, if not well-managed, the second generation of cross-breeds may show a decrease in production and are vulnerable to various diseases. He also mentioned that consumers do not prefer sheep meat. Regarding

processed farm products, the representative said, “Processed foods from milk, eggs, and meat need more improvement and if the processor companies can be linked with the producing farmers, then a good industry can be built.”

A DAE Deputy Director stated that farmers are frequently cultivating vegetables alongside their rice crops in Cox’s Bazar. He also described the expansive cultivation of genetically engineered varieties, providing the examples of Bt brinjal, which is being grown on 1,350 hectares of land; and hybrid tomato varieties, which are being cultivated on 1,300 hectares. He recently received 7.5 kg of Bt brinjal seeds, which was distributed to farmers. Also, in Teknaf and Ukhia upazilas, farmers are cultivating watermelons, which have been profitable thus far. He noticed that research institutes are prioritizing seaweed in Cox’s Bazar, which is sidelining attention from other crops.

Another participant stated that the marketing of hybrid crops is doing well, perhaps in part by the influx of Rohingya population and tourists in Cox’s Bazar. He added that they even have to import products from other districts to meet the market demand. While this is encouraging, this participant reiterated that climate change and untimely rain in the summer hampers cultivation. Ramu, Ukhia, and Teknaf upazilas frequently suffer from both drought and irrigation issues in the winter. Furthermore, new and advanced hybrid seeds are not easily available as they only distribute seeds sourced from BARI, DAE, or BADC.

An Upazila Agriculture Officer (UAO) from Ramu upazila said that huge quantities of vegetables like tomatoes, potatoes, and green pepper are being cultivated, which are all hybrid crops. Farmers prefer the local potato variety over the hybrid variety, even if it gives less yield. Most vegetables are cultivated at river banks, which may increase the risk of bacterial attacks.

One of the moderators mentioned that private seed companies are not allowed to develop genetically engineered varieties or multiply seeds of genetically engineered varieties: only BADC and national agricultural research institutes can do this.

The DAE Additional Deputy Director of Cox's Bazar asserted that DAE cultivates *BRR1 Dhan 74, 52, 84, 71*, and similar varieties that have high zinc and high yield. It can be more challenging to market these rice crops as consumers prefer thicker rice grains.

A Department of Livestock Officer (DLO) asserted that due to geographical diversity, livestock potential varies by geographic area. He mentioned that the influx of 11 lac Rohingya (~1.1 million) is putting a strain on livestock products of Cox’s Bazar, but they are still able to provide eggs for the whole population. To address this issue, the government plans to give farmers logistical support through a government subsidized program. Also, they are trying to artificially increase the production of cattle like Friesian cows; the research is ongoing.

The District Food Safety Inspector asserted that farmers are using pesticides on agro-products and antibiotics on poultry. These agro-products are often entering the market without any supervision. The inspector advocated for stronger monitoring and testing of agro-products to ensure they are safe for consumption before they reach the market.

Hazardous substances are frequently identified during inspections of dried fish at the processors’ and farmers’ levels, as well as fish are washed in the same water repeatedly, which is not hygienic. Although there are machines available and the government has provided a special water mixture to wash and dry the fish, these methods increase production costs for

farmers. More research to identify a suitable method and special training is needed to rectify this problem as the fish have a good market demand.

For poultry products like milk, many processors do not have any training on how to correctly preserve the product. There are many inspection points to control milk quality and agents marketing sub-optimal milk are being fined, but market training should still be mandatory to improve food safety.

The Deputy Research Director, Agricultural Policy Support Unit (APSU) reiterated that further research is needed on developing new hybrid varieties for rice and vegetables to attain the SDG target for 2030. He added that researchers must carefully consider characteristics of newly-developed varieties in crop and non-crop agriculture to ensure consumer acceptance. Also, farmers should be properly trained on integrating crop and non-crop agriculture, especially as many farmers engage in diverse farming activities across crop, livestock, and fisheries in Cox's Bazar.

Another Deputy Research Director from APSU asserted that farmers tend to accept hybrid species if the productivity is high. She suggested that the farmers need to learn about the health benefits and nutritional values of the hybrid species. Also, the market needs to be developed to motivate farmers to cultivate more.

3.2 Perspectives from Agricultural Value Chain Actors

A farmer from Ramu started Bt brinjal cultivation after a government demonstration and the yield was estimated to be good. He did not use any pesticides on his Bt brinjal because his crops were not infested by pests. However, before he could harvest, a plant disease killed all his crops. One of the moderators said that a bacterial wilt likely damaged his Bt brinjal crops and the fungus will attack again if he continues to cultivate without any intervention. This fungus thrives in the hot and humid weather of Cox's Bazar. He suggested treating the land to help uproot the fungus, keep a year gap between brinjal cultivation, and strictly follow the Bt brinjal cultivation pattern, if possible.

A Bt brinjal farmer reported that his Bt brinjal had good yield and received a good market price from last year's harvest. Local brinjal varieties typically sell at BDT 20-25 (~\$0.25), whereas his Bt brinjal sold at BDT 30-35 (~\$0.40). Although not discussed during the consultation, Shelton et al. (2020) indicates that the price of brinjal varies by the market in Bangladesh.¹ The study found that Bt brinjal, on average, sells at a higher rate across all markets (Bt brinjal: BDT 15.78/kg vs. local brinjal: BDT 15.51/kg). Bt brinjal may get a higher price compared with local varieties because it tends to be less affected by pest infestation and uses minimal (or no) pesticides, which can be appealing to consumers and some market actors who trade brinjal. Less infestation also means that the Bt brinjal may look better, which is aesthetically appealing to consumers. The participating Bt brinjal farmer in the workshop confirmed that he would grow other varieties similar to Bt brinjal, and has provided Bt brinjal seeds to other farmers who were interested in cultivating the variety.

¹ Shelton, A. M., Sarwer, S. H., Hossain, M. J., Brookes, G., & Paranjape, V. (2020). Impact of Bt brinjal cultivation in the market value chain in five districts of Bangladesh. *Frontiers in Bioengineering and Biotechnology*, 8, 498.

A fish farmer said that he cultivates tilapia and pangash fish. He rears a hybrid tilapia fish species and the market price for the fish is good. He collects the fish eggs from a local hatchery named 'Alahwara,' which provides good quality fish eggs. He also cultivates Bt brinjal and collects its seeds from BARI for free. However, even if BARI does not provide him the seeds, he is willing to buy the seeds if they are available in the market.

A fish farmer attested that he cultures tilapia, pangash, and carp fish. The tilapia fish fingerlings are available in the local hatcheries, but he has to source the carp fish fingerlings from Cumilla, which makes him question the product's quality. He purchases his fish feed from a hatchery called 'Niribili Tilapia Hatchery' and a private company called 'Krishibid;' the price of the fish feed is high.

Another farmer rears cows and has four Sahiwal cows, which is a Pakistani breed. He said that he rears this breed of cow because it produces 10 liters of milk daily. He either prepares his cow feed or buys the feed from the market. He sources the semen from the government offices and has an available vet. In addition to cattle rearing, he cultivates Boro rice. He confirmed that he would cultivate new, advanced varieties of rice and or rear cattle if they are available to him and he is informed about them.

3.3 Perspectives from NGOs, Private Sector, and Other Participants

Although ACDI/VOCA's RDC project is not active in Cox's Bazar, an ACDI/VOCA representative discussed market opportunities for local processors as a result of the Rohingya population. He added that the Food and Agriculture Organization (FAO) is already working to ensure nutritious food like zinc-fortified rice for the Rohingya population. "There is only one processor machine stationed in Chakaria; thus, there is an opportunity for SMEs in Cox's Bazar to meet the rising demand from tourists and the Rohingya population." He suggested that production should be in sync with the population's demand and preference.

He said that the government is trying to promote and utilize marine products. Currently, the lack of high-quality food processing limits products to certain times of the year. Dried fish, for instance, could be sold in the domestic market year-round or international market if high quality processing was available.

The ACDI/VOCA representative suggested (1) linking fish farmers with processors, and (2) establishing dried fish as an organic and safe product without using any sort of harmful chemical substance. Furthermore, he added that if seaweed can be commercialized, then the bio-regulator substance sourced from seaweed can be produced domestically, which Bangladesh is currently importing from abroad. In Japan, seaweed is processed into high-priced food items; therefore, Japan could be an export market for Bangladesh's emerging seaweed.

A representative from Green Agro Limited is cultivating cocoa, mushroom, and coffee. She consulted through the internet for searching machinery to process her coffee, mushrooms, and cocoa. She said that she would benefit from the government's support in validating which machinery to use, and the quality of the machinery and her products.

She is also involved with dairy farming, but is not seeing a proper market for her dairy products. She also cultivates seaweed and currently has more than 200 MT of seaweed stocked. She pointed out three problems in commercializing seaweed: (1) lack of proper packaging, (2) inadequate market linkages, and (3) transportation-related issues.

A non-Bangladeshi participant asserted that although nutrition is an important factor for biofortified crops, farmers' production decisions tend to be more driven by high yields.

3.4 Concluding Findings

- Increased seaweed seed availability is needed to meet farmers' demand to produce seaweed.
- Fish hatcheries need to be protected from the effects of climate change and natural disasters.
- Dried fish are mostly processed by small processors. Many agricultural value chain actors cannot utilize the improved technologies to process dried fish because it increases their production costs substantially.
- Further research is needed on how to ensure fish quality and manage the market price.
- BLRI is promoting new breeds of sheep, cows, goats, and chicken. However, many farmers are still rearing traditional cross-breeds. In particular, sheep have no market demand as the consumers do not prefer it. A linkage between processors and farmers would be beneficial.
- Crop varieties that are suitable to the climate need to be developed and promoted. In particular, summer-suited varieties and a short-duration Aman rice variety should be promoted, as they can be accommodated in the existing cropping pattern in Cox's Bazar.
- Farmers have had good experiences cultivating BARI *Bt Brinjal 3* and *4*; however, its production remains limited as the crop is winter-based and winter is short in Cox's Bazar.
- Further research on developing bacteria-resistant varieties is needed, particularly for tomatoes.
- BLRI is promoting RCC cattle, hilly chicken, and other varieties, which are in high demand, but there are shortages of these breeds.
- Zinc rice and other biofortified crops are increasingly entering the market, particularly since many NGOs and FAO are providing biofortified crops to the Rohingya population, but many consumers prefer fine rice.
- Farmers are eager to cultivate new hybrid species/varieties if the products are available to them.
- More marine crop seaweed seed production facilities need to be established, and strategies to overcome barriers to commercializing seaweed should be identified (e.g., lack of packaging, market linkages, and transportation).
- Information should be provided to entrepreneurs on where to source high-quality machineries to help commercialize their products.

4 DHAKA DISTRICT

On December 8, 2020, USAID organized and IFPRI facilitated a stakeholder consultation to glean insights from representatives on the status, opportunities and challenges, and recommendations related to the commercialization of agricultural research and biotechnology in Dhaka.

4.1 Perspectives from Government

A Member Director (Crops) from BARC stated that agricultural technologies in Bangladesh have increased yields of different crops and raised agricultural productivity. Various stress-tolerant varieties have been developed, which have benefited farmers. For example, BARI recently developed *BARI Wheat 33*, a wheat blast-tolerant variety. He also mentioned that different regions of Bangladesh pose unique challenges. “Depending on the regions, we need to think about which types of resistances are required for the crops.”

On a broader level, the Additional Secretary of the Ministry of Agriculture emphasized the importance of biotechnology research as a vehicle to enhance agricultural productivity. He also mentioned the lack of dedicated scientists in the field of agricultural research.

Furthermore, he stressed the importance of high-value, high-yielding, and short-duration crops for enhancing productivity. In southern Bangladesh, most of the land is under a single cropping pattern. Apart from rice, one or two crop varieties, such as mungbeans and sunflowers, are cultivated. BARI is conducting pattern trials to assess what to cultivate and how in specific geographic areas. To intensify crop cultivation, mechanization in all stages of production is necessary. On a broader level, coordination between research, extension, private sector, and NGOs is needed.

Biotechnology research is an important step towards making agriculture more resilient to emerging issues, such as diseases and pest infestation. One of the moderators also mentioned that BARI has already released varieties of Bt brinjal, and IFPRI’s evaluation of Bt brinjal was largely positive.

The Deputy Director of the Department of Fisheries (DoF) stated that Bangladesh has already achieved self-sufficiency in fish production; however, sustainable fish production is a major challenge. There has been a loss in biodiversity, and there are serious risks of eliminating indigenous species unless actions are taken to preserve and replenish these varieties. To this end, one concrete suggestion that was given is to focus on preserving the sperm of indigenous species to ensure their continuation. Also, farmers require access to low-cost feed to improve production, profits, and reduce dependency on imported feed. Given this, diversifying feed that can be locally sourced for farmers should be a priority. Furthermore, genetically improved breeds and local production of probiotics can help overcome challenges in the fisheries sector.

A participant discussed the status of fisheries research and productivity. The Department of Fisheries is expanding fish production, particularly through the cultivation of tilapia, pangash, pabda, silver carp, and grass carp. Expanding production of these nutritious fish can also contribute to healthier diets for the poor. National researchers are applying bio-preservation methods to maintain the fish supply in the country.

According to the Additional Director of the Bangladesh Cotton Development Board, the Board has been working with the private sector since 2008 to produce high-quality seeds, including Supreme, Lal Teer, and ACI. They are working on sustainable cotton production for international clothing companies Primark and H&M; however, the key challenge is meeting the requirements in transitioning from a chemical to a non-chemical procedure. Since cotton is saline-tolerant, the Bangladesh Cotton Development Board has set up two frontier research stations in a dry area and in the coastal region. Another challenge hampering cotton cultivation is inadequate labor, which delays or lowers production.

Bangladesh has largely mechanized land preparation and irrigation; however, sowing, planting, harvesting, and drying operations are largely done manually. The General Manager of Alim Industries mentioned that a lack of affordable, appropriate, locally-made agricultural machineries is a key challenge. Local agro-machinery companies engaged in assembling are finding it difficult to compete with imported machineries due to the higher duty on machine parts and lower duty on imported machineries. The market size is small and does not justify private investment in research and development. To this end, the government should facilitate a strong collaboration between research agencies and the private sector, and support opening up export opportunities (e.g., removing tariff barriers). Increased mechanization is important to reduce production costs, turnaround time, and minimize the labor crisis.

He also mentioned how mechanizing agriculture, particularly during planting and sowing of crops, can increase profitability. “For harvesting, we are not using enough machinery and we are mostly relying on sun drying. These are some areas where we can focus mechanization on. Also, private companies want these sectors to be subsidized by the government. Thus, support from the government is necessary,” he added.

An official from the Department of Livestock discussed the department’s limitations in providing necessary inputs for livestock farmers. For instance, producers face challenges identifying the appropriate vaccines for their animals.

A representative from BARI stated that the development of new genetically engineered varieties must consider crop zoning, customer demand, and climate change. He mentioned that more programs should be initiated to create more awareness on genetically engineered crops among consumers. The biosafety guidelines do not differentiate between local or foreign technologies.

The BARI representative stated that biotechnology research can be very expensive; therefore, careful decision making is required to assess which crops to prioritize and whether the issue can be solved by conventional technology. To this point, the BARI representative clarified that biotechnology does not always mean genetically engineered. Under the influence of the media, most stakeholders discuss clustered regularly interspaced short palindromic repeats (CRISPR) processes and gene-editing, but this does not apply to all areas of biotechnology. “We must focus on the non-genetically engineered part of biotechnology and complying with biosafety regulations. For instance, tissue culture is a very big area, and we can easily grow banana and strawberry through tissue culture. This does not require any prohibitive regulation. The other option is a marker-assisted breeding system. High quality breeding can be achieved via molecule marker and gene-identification. The trade-related marker must be identified. Lastly, we must start working on these things in all research institutes and in the private sector because marker-assisted selection can be implemented in animal-rearing industries and fisheries.

Although agricultural research continues to advance and the national facilities are gradually improving, skilled labor is still a problem.”

A BARC representative stated that the biosafety guidelines do not differentiate between local or foreign technologies, apply to everyone, and involve various stakeholders throughout the process. In addition, he stressed the importance of adequate pricing schemes for producers.

The Additional Secretary from the Ministry of Agriculture reinforced the importance of Bangladesh continuing to follow the international biosafety guidelines. The approval process is overseen by the Bangladesh Agricultural Research Council (BARC), the Ministry of Agriculture (MoA), and the Ministry of Environment, Forests and Climate Change (MoEF). Currently, the biosafety guidelines are inconsistent among South Asian countries, but an Expert Working Group (EWG) is working on harmonizing the biosafety guidelines in the region.

4.2 Perspectives from NGOs, Private Sector, and Academia

A Professor from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) stated that he recently set up a department on biotechnology and genetic engineering, where frontier research technologies are being used to develop wheat varieties. They have also developed a PCR strip, which works like a pregnancy strip for wheat blast identification.

A representative from the national NGO Shikha Shastha Unnayan Karzakram (SHISUK) stated that there is a lack of awareness on biotechnology in Bangladesh. Given this, it is important that consumers are able to distinguish between biotech and non-biotech crops through proper labeling in the market.

A representative from Lal Teer Seed Limited stated that they are producing new crop breeds from their own research, as well as taking different materials from national agricultural research institutions. They have also designed and implemented different policies that enhance the marketability of products. In addition to helping breeders, Lal Teer is working on developing new crops using biotechnological approaches.

4.3 Concluding Findings / Opportunities

- Monitor biosafety guidelines and ensure these guidelines are being followed properly.
- Open up markets for agro-machineries to increase agricultural production.
- Biotechnology research is very innovative, albeit an expensive method of research. Carefully optimize resource allocations across conventional and biotechnological approaches to ensure that research is both technically effective and cost-effective.
- Properly label biotech products in Bangladesh so that consumers can differentiate products that are not genetically engineered.
- Increase the supply of medicines and vaccines for animals, which are in short supply in Dhaka and nationally.

5 JASHORE DISTRICT

On December 9, 2020, USAID organized and IFPRI facilitated a stakeholder consultation to glean insights from representatives on the status, opportunities and challenges, and recommendations related to the commercialization of agricultural research and biotechnology in Jashore.

5.1 Perspectives from Government

A Principal Scientific Officer from BARI has been working on biosafety for genetically engineered crops, especially three varieties of genetically engineered potatoes. He opined that to release a genetically engineered crop, an application must be sent to the Ministry of Agriculture (MoA) via three organizations: (1) the Institutional Biosafety Committee (IBC), (2) the Core Committee of the National Technical Committee on Crop Biotechnology (NTCCB-Core), and (3) the National Technical Committee on Crop Biotechnology (NTCCB). Next, the application goes to the Department of Environment (DoE), where clearance is required by the Biosafety Core Committee (BCC) and National Committee on Biosafety (NCB). Due to procedural delays (e.g., meetings do not take place as scheduled), it often takes around two years for the DoE to approve a species. A genetically engineered crop cannot be released without approval. He suggested that having researchers on the committees may expedite the approval process. Also, except for Bt brinjal, no other genetically engineered crop is being produced on a large scale. Genetically engineered hyacinth beans have received clearance from the DoE, but are still not being widely produced and commercialized.

A Senior Scientific Officer from the Bangladesh Fisheries Research Institute (BFRI) provided an overview of fisheries in Jashore and identified key priorities. Jashore contributes about half of the total fish fingerling production in Bangladesh. BFRI research has contributed to the development of 'super tilapia,' which is 40 percent larger than the conventional variety, and rui fish, which is 20 percent larger than the traditional variety. BFRI is now trying to increase the growth of cultured species like carp and tilapia. Bangladesh is producing 200 crore tilapia fish eggs every year. Moreover, a USAID-funded activity implemented by WorldFish is working on increasing the local rui fish size by introducing an Indian Rui fish gene. Thus far, the research has contributed to increasing the growth of fish production by 30 percent, and plans to reach 45 percent by 2022. "The Indian Rui weighs around 2-3 kg, whereas the local Rui is currently around 800-1,200 grams," the participant said. Regarding the status of disseminating these varieties to farmers, a technical moderator added that BFRI is providing 'Super Tilapia' fingerlings to hatcheries, covering about 40% of hatcheries in Mymensingh. The hatcheries produce more generations via monosex tilapia. Then, they sell fingerlings of monosex tilapia to the fish farmers (which is also available in the market).

The BFRI Senior Scientific Officer identified a few challenges in the fisheries sector in Jashore. One example is fish stocking. Another issue is the price hike of imported pituitary gland from fish in India, which has increased dramatically as a result of the COVID-19 pandemic. He suggested that companies like United Agro Fisheries, which already processes fish, can be trained to extract and preserve the fish pituitary gland, which is used for fish egg production. Moreover, district-level preservation mills for pituitary gland can be established, which could ensure safe inbreeding of fish. If fish retailers, marketers, or sellers could also be trained to source the gland, it can become a good export product in the future.

A BARI Scientific Officer identified crops that are widely cultivated in Jashore that suffer from numerous issues. For example, lentils are susceptible to foot and root rotting diseases, brinjal is vulnerable to bacterial wilt, and chickpeas suffer from pod borer attacks. Genetic engineering could be used to research and develop disease-resistant varieties of these and other susceptible crops. BARI has already developed two disease-resistant varieties of wheat, which counter the wheat blast disease, and two disease-resistant varieties of potatoes (*BARI Potato 46* and *53*). Blast-resistant wheat varieties, which are not genetically engineered, are already in the field being used by farmers. BARI's development of genetically engineered potato varieties is currently underway.

The Principal Scientific Officer of the Regional Agricultural Research Station (RARS) stated that farmers like cultivating *BARI Bt Brinjal 4*, but many do not consume it themselves because of concern over food safety. DAE field officials are distributing Bt brinjal seeds to the farmers; however, BADC and BARI are unable to provide an adequate supply of Bt brinjal seeds to all farmers who are interested in cultivating the variety. Furthermore, many farmers have requested Bt brinjal varieties that are similar to their local brinjal varieties, which farmers believe could fetch better market prices and have wider consumer acceptance because of its similarities within the conventional variety. The Principal Scientific Officer also suggested that farmers sell Bt brinjal separate from other varieties, showcasing pesticide-free produce. Through this, the market value of Bt brinjal can increase.

The Jashore Deputy Director of DAE provided an overview of Jashore's agroecology and cultivation conditions. Most of the land in Jashore is highland or mid-highland with loam soil, which makes Jashore suitable for all kinds of cultivation. Jashore's cropping patterns primarily consist of Boro and Aman rice cultivation. This cropping pattern leaves land vacant between the two harvests. Besides rice cultivation, many farmers prefer fish farming on flood waters. Less than 3 percent of land is used to cultivate pulses, and this is declining as farmers are increasingly cultivating fruits like lemon, mango, and dragon fruit, which are more profitable.

Submergence is a major issue in Jashore, with approximately 2,880 hectares of land flooded in Manirampur, Abhaynagar, and Keshabpur upazilas. Excess rain has overflowed the dams, destroying both fish and Boro paddy cultivation areas, as the water remains stagnant in the fields for an extended period of time.

Regarding Bt brinjal, he stated that *BARI Bt Brinjal 4* is doing well, but the other Bt brinjal varieties have a bitter taste, harder skin, and are smaller in size, which lowers consumer demand. Although Bt brinjal requires minimal to no pesticide use, the Deputy Director indicated that DAE field-level officials are advising farmers to use the appropriate amount of pesticides for other vegetables (as opposed to overusing pesticides). Further attention should be given to ensure farmers have knowledge of and access to effective organic methods for cultivation, which can reduce the use of pesticides and hazardous substances. Insufficient market linkages for selling vegetables remains a key challenge; if farmers get proper market linkages, they will be more eager and able to maintain the product quality.

The Deputy Director, Department of Livestock Office (DLO), Department of Livestock Services (DLS) identified several challenges in the livestock sector. Many dairy farmers state that the market price for milk is inadequate given the high dairy production costs. Also, there are often supply shortages of animal feed, which can affect the production costs for farmers and, in turn,

the market prices for consumers. Actions are needed to ensure a stable supply of animal feed. Furthermore, there are no large milk processors in Jashore except for Afil.

The Jashore Deputy Director of the DAE also discussed challenges and opportunities related to flower cultivation. Improved flower seeds are still being imported; thus, research is needed on developing improved flower seeds locally. He also indicated that proper shading must be built for the sensitive flower varieties. Furthermore, he added that there is currently a USAID-funded flower cold storage in Jhikargacha, which provides storage, packaging, and selling benefits to farmers. Nevertheless, transportation is still a problem in the region. Currently, biofortified species for marigolds and roses are available domestically, yet more research on other varieties is required. The cropping patterns in Jashore also need further research, he recommended.

A representative from the Bangladesh Flower Society added that adequate equipment for flower cultivation is not present in the USAID's flower storage and processing center. COVID-19 has had adverse consequences on the flower sector as a result of plummeting consumer demand. He requested the government to consider relaxing the event ban so that flower demand increases and the sector can rebound.

A UAO in Jhikargacha upazila stated that 650 hectares of Jashore are dedicated to flower cultivation. Despite the continued expansion of flower cultivation in Bangladesh, the country is still heavily reliant on imported seeds. There may be an opportunity to use biotechnology to reduce Bangladesh's dependency on imported flower seeds, while also improving the color, shelf-life adaptability, and productivity of flowers. For flowers, post-harvest management is critical in maintaining the quality of the products, with the flower market in Jhikargacha valued at approximately BDT 200 crore. Lastly, on the topic of *BARI Bt Brinjal 4*, he added that the roots of *BARI Bt Brinjal 4* become thin by harvest.

The Deputy Research Director of the Agricultural Policy Support Unit (APSU) stated that there is a gap between the processor price and consumer price. Attention must be given to ensure that farmers are getting an adequate price, too. Also, 25 percent of produced crops are being wasted every year, which should be prevented through more research and use of technology at an area-based level.

A UAO in Magura district asserted that the government has released many specialized varieties like zinc rice, but the market is still dominated by traditional varieties like *BRR1 Dhan 28*. If the specialized crops could be turned into a brand, then they could be more successfully commercialized.

A DLS official asserted that proper marketing and storage are needed to prevent farmers' milk losses. Companies like Aarong and Milk Vita have chilled storage capacity for milk, but it is insufficient to cover the total milk production. As such, she stressed the importance of increasing chilled storage and ensuring market linkages for dairy farmers.

Farmers learn about improved varieties of farm animals from the office or through workshops and events. The official is aware of the new Multi-Colored Chicken (MCC), but it needs to go through field trials before she can judge its productivity. She stated that farmers are often unaware of the insemination regulations, and often want 100 percent insemination even though the maximum level that government technicians recommend is 88 percent. This lack of awareness can cause various problems for cattle.

5.2 Perspectives from Agricultural Value Chain Actors

A participating seed dealer shared that biofortified seeds are not available in adequate amounts and thus, he could not meet the demands of the farmers as hybrid seeds for rice and vegetables are low in supply. He also said that he sources the seeds from BADC and private companies like Lal Teer. He added that vegetable seeds for onions, cabbage, cauliflower, and similar crops alongside *Boro Dhan-63* are not widely available in the market.

An input dealer stated that he started producing zinc-enriched rice seeds via Harvest Plus, which is no longer active and now he is struggling to sell his seeds via seed dealers to the farmers as BADC also provides these seeds. He suggested that farmers and input dealers need proper training to handle zinc rice seeds.

During the workshop, a seed provider stated that he supplies zinc rice (*BRRl Dhan 28, 50, 63, 74, and 84*). He sources these seeds from private companies, particularly from the USAID-funded Wave Foundation. He testified that zinc rice cultivation is increasing every year.

One participating seed trader produces 35-40 MT of seeds annually, of which 12 MT are zinc rice this year. He sources the seeds from BRRl and produces the crop via contract farming with 12 farmers. Although zinc rice is gradually becoming more popular, the first-time sale to consumers raises some challenges and continued promotion of the variety would be beneficial for increased market acceptance. He argued that he cannot compete with the BADC seed prices since he also has to cover his own operational costs, and more training for seed dealers on how to handle and sell seeds is required.

One trader confirmed that he does not buy zinc rice, and has not heard of it in Churamonkathi region, and there is no market demand for it.

During the workshop, a fish farmer chimed in about his experiences cultivating *G3 Rui* fish. He had collected the *G3 Rui* hybrid fish eggs from a USAID-funded project implemented by WorldFish. Compared with the local Rui, the *G3 Rui* is more productive, larger, consumes less feed, and looks more appealing to the consumers. Other farmers reported positive experiences cultivating *G3 Rui*, too.

When asked about the selling price of the *G3 Rui*, he stated that he is currently selling the fish larvae as the fish have yet to mature. He added that each larva is priced BDT 3 and these larvae can develop into a fish weighing around 3-4 kg. "Due to the recent floods, we are facing financial strains as there are troubles in selling the products in the market. If a low-interest loan was available to us, then we could manage fish farming better."

One of the participants has been a fish farmer for the last two years. He cultivates local rui, kattla, and tilapia fish varieties. The main issue he mentioned is expensive fish feed, although it is available in the market. He currently has two ponds and could increase the number of ponds he has to multiply his production if he wants. If he gets *G3 Rui* fish eggs, he would be eager to cultivate them.

A farmer from Manirampur shared his experience cultivating zinc rice. He initially received the zinc rice seeds first from Harvest Plus in 2013. He started producing *BRRl Dhan 62*, then switched to *BRRl Dhan 63, 72, 74*, and now *84*. According to this farmer, *BRRl Dhan 84* is good and the market price is reasonable, but if they could stock the crops, they might get a better price. He said that *BRRl Dhan 62* and *84* are popular now. Additionally, with all the promotions

about zinc rice, the market price of it is also better. He further added that he sells the rice crops to millers at a good price and the rice beads of the crops are fine like *BRRR Dhan 28*. The farmer also confirmed that the rice does not go soft after cooking and he consumes the rice himself.

A farmer from Jashore Sadar shared that he cultivates zinc rice crops. He has been cultivating zinc rice since 2013, starting with *BRRR Dhan 62*, and then *BRRR Dhan 72* and *74*—sourced from Harvest Plus. Although the zinc rice seeds are still not easily available, the yield is higher and the market price is slightly better than the local varieties like *BRRR Dhan 52*. He is still cultivating zinc rice by sourcing the seeds from BADC.

A rice farmer attested that bio-fortified rice crops demonstration just made it to his area. A farmer he knows has planted zinc rice *BRRR Dhan 66* but he is still not clear about the zinc rice and would cultivate it if the results of the farmer's yield are good. He added that golden rice is yet to make it to his area.

Another farmer from the workshop cultivates *BRRR Dhan 28*, *50*, and *63*. He does not cultivate the new hybrid rice crops and stopped growing *BRRR Dhan 28* because some of the crops rot away in harvest time.

Another farmer has been exclusively cultivating *BARI Bt Brinjal 4* for the last four years. According to this farmer, *BARI Bt Brinjal 4* can be harvested until May and sells well in June, when the local brinjal varieties are not available in the market. He reiterated that *BARI Bt Brinjal 4* requires no pesticide spraying as there is no infestation compared with traditional brinjal varieties. The only problem is that the skin of *BARI Bt Brinjal 4* is a little tough, which makes it more difficult to sell.

One Bt brinjal farmer spoke about his positive experiences cultivating Bt brinjal: it is profitable, does not require any pesticide use, and thereby reduces his production costs. He collects the seeds from BADC and cultivates the crop according to the advice of the agricultural officials. He has noticed that there are too many seeds inside of *BARI Bt Brinjal 4* fruit, which is one drawback of the variety.

5.3 Perspectives from NGOs, Academia, and Private Sector

A representative from the USAID-funded RDC project from ACDI/VOCA had various recommendations for high potential varieties which could be developed. For instance, he stated that single-skinned black sesame has international demand, which could be a research opportunity. In addition, he suggested developing a mungbean variety where all the pods could be harvested on a single-term. Similarly, he suggested developing a virus-resistant lentil crop. Although *BINA Lentil 9* is in the market and is virus-resistant, it has thicker beads, whereas consumers prefer thinner beads. Furthermore, there is scope to develop a high oil content and high yielding mustard variety, as well as submergence-tolerant varieties that are also short-duration. He further added that if a better variety of Aus dhan could be discovered, then this could align with the government's current promotion of Aus rice crops over Boro. Similarly, for livestock, he stated, "It would be better if farmers could produce their necessary animal feed, which would reduce their reliance on DLS for animal feed." Lastly, if zinc rice could be promoted as a brand, it would help commercialize the variety further.

Another representative from the USAID-funded RDC activity implemented by ACDI/VOCA noted that imported artificial flowers have a negative impact on the flower market in Jashore. To this

end, the participant suggested enacting a flower policy to protect the local flower market. He added that with good cultivation practice, it is possible to expand to the international flower market.

A WorldFish Program Officer asserted that WorldFish has recently released *G3 Rui* via four nurseries to approximately 50 farmers in July 2020. Findings from a recent farmers' survey shows that the *G3 Rui* are performing well thus far.

A representative from Harvest Plus stated that they have sold 65 MT of zinc rice, consisting of *BRR1 Dhan 74* and *84*. In addition, they are also branding zinc rice, raising awareness from farmers to consumers, building market linkages, as well as training farmers and processors. As a result, the zinc rice is growing in popularity and is rendering a good price to the farmers and processors. Despite zinc rice's potential, he stated that the seeds are not widely available.

The Animal Science and Nutrition Department Head of Jhenaidah Government Veterinary College provided various suggestions based on the discussion. First, she pointed out that agriculture is closely related to livestock rearing as traditionally farmers used to use crop residues as cattle feed. However, due to the usage of cropping machines, a lot of crop residue is rendered useless. The stakeholder asserted that gene modifications are making the residues shorter in the ratio of the crops. Also, many farmers have the tendency to choose Friesian cows for insemination without actually keeping any records of the process. They also are unaware of the inbreeding problems that can occur due to artificial insemination. Improper use of medicines and usage of pesticides on crops also poison the residues, which could be used as feed for the cattle. She suggested that biotechnology could be used to increase the ratio of crop residue. Expert help could be provided for feed formulation via online platforms or specialized companies. Further trainings could be conducted on insemination, and in particular, the importance of following regulations to mitigate inbreeding defects.

For poultry, she suggested that the best productive local breeds should be enlisted and researched to maximize their potential. For lakes or flooded areas where fish farming occurs, ducks can be raised, which could provide duck residue as fish feed. It would also increase the oxygen circulation in the water naturally as the ducks will be swimming in the ponds.

A Professor from Jashore University of Science and Technology (JUST) expressed interest in collaborating on flower biotechnology research with research organizations, and agreed that flowers need preservation facilities to enter the international market competitively.

A representative from United Agro Fisheries (UAF) mentioned that UAF is the first company that works with pituitary gland, which is essential for fish reproduction. Bangladesh needs 40-50 kg of pituitary gland, whereas UAF's capacity is only around 10 kg. Furthermore, under a World Fish project, he had trained 300 fish cutting workers to extract and preserve the pituitary gland, whereas Bangladesh requires 2,000 fish cutting workers to meet the demand. To make up for this deficit in skilled personnel, this training on extracting and preserving pituitary gland should be expanded to farmers, nursery members, and hatchery members. He also attested that they are collaborating with USAID's Feed the Future project on the "Strengthening Quality Carp Pituitary Gland (CPG) Production Domestically to Ensure Quality Fish Seed at Hatchery Level" project. He also cultivates the *G3 Rui*, which has good productivity and market potential.

A representative from Akij Dairy said that they have a milk storage capacity of 20,000 liters and have collected 13,000 liters of milk, which is below its capacity. The farmers are unaware of the

optimal diet for cattle and many do not know how to milk their cattle, which causes the milk quality to deteriorate. Some farmers get their cattle milked by an outside source, who buys it at a low price, or sources it to the grocery stores, which lowers their profit margins. Given this, he recommends that farmers should be properly trained on cattle milking.

5.4 Concluding Findings

Participants in the Jashore consultation workshop provided several recommendations for commercializing agricultural research and biotechnology in the region, which are summarized below:

- Foster collaborations between research organizations and regional seed companies to conduct research and develop high potential varieties that are appropriate for the region, such as single-skinned black sesame beans, single-termed mungbean, higher yield and oil content mustard varieties, short-duration and submergence-tolerant varieties, disease- and bacterial-resistant varieties, as well as higher quality aus varieties.
- Improve marketing of zinc rice to raise awareness of the variety's benefits for producers and consumers
- Develop new flower varieties through conventional breeding that may improve productivity, reduce costs, improve shelf-life, and vary the colors of flowers.
- Conduct further research on increasing fish size and stocks, and cultivating pituitary gland locally
- Train fish sellers, retailers, and processors to extract and preserve the pituitary gland in fish to reduce Bangladesh's import dependence on India.
- Raise awareness and train cattle farmers on proper recordkeeping for artificial insemination to avoid inbreeding problems
- Integrate fish and duck breeding to lower the fish feed cost as well as increase the flow of oxygen in the water
- Link consumers and processors to ensure adequate prices for farmers.
- Department of Agriculture Marketing (DAM) may establish small storage points in districts to reduce waste as a result of transport issues and improve profitability.
- Integrate fisheries, crop, and livestock farming, which can produce by-products for each other.
- Improve access to finance so that fish farmers can get loans to afford fish feed and other necessary inputs
- Expand cold storage facilities for milk, as the chilled storage points provided by the private sector (e.g., Milk Vita, Aarong, and Akij Dairy) are still insufficient
- Train farmers on how to properly feed and milk their cattle to ensure high quality outputs
- Develop Bt brinjal varieties that are similar to local varieties to improve market acceptance and raise consumer demand
- Increase production and distribution of Bt brinjal seeds to farmers

6 KHULNA DISTRICT

On December 10, 2020, USAID organized and IFPRI facilitated a stakeholder consultation to glean insights from representatives on the status, opportunities and challenges, and recommendations related to the commercialization of agricultural research and biotechnology in Khulna.

6.1 Perspectives from National Agricultural Research Institutes and Government

A BARI representative has been working to increase cropping intensity in Dacope upazila for five years. He stated that Boro rice should be completely discouraged. For cultivating potatoes and garlic, he recommended using relay cropping and zero tillage methods. He suggested cultivating fine tillage crops with the use of high-speed rotary tillers. Drip irrigation can be used with crops like watermelon and pumpkins. For vegetable cultivation, he recommended farmers to excavate small ponds and cultivate vegetables on the pond shores to minimize salinity.

Another BARI representative added that mungbeans can also be cultivated in Khulna with the use of high-speed rotary tillers. The main challenges for mungbean cultivation are thrips and pod borers, which can be solved by high-speed rotary tillers. He also mentioned the government project 'Ekti Bari Ekti Khamar,' which focuses on improving vegetable and fish cultivation.

A Principal Scientific Officer from BARI shared his observations of Bt brinjal cultivation in Khulna. Overall, farmers have had positive experiences cultivating BARI *Bt Brinjal 4* in Khulna, with one farmer earning BDT 5 lac from its cultivation. In Satkhira, BARI *Bt Brinjal 4* should be sown in October and harvested by November. If the brinjal comes into contact with the summer heat, its skin hardens and the fruit shrinks. He mentioned that Bt brinjal is an open-pollinated variety and farmers can produce their own seeds. It is better if Bt brinjal is surrounded by other crops to reduce pest infestation in the future. Training for the farmers is available under various programs. Despite the Bt brinjal's many advantages, many consumers prefer local brinjal varieties because of the taste.

On a separate note, he also mentioned that late blight disease in tomatoes and potatoes is prevalent in Khulna. To address this issue, BARI has developed *BARI Potato 36* and *56*, which are late blight-resistant varieties, and is working on developing new late blight-resistant potato varieties.

In the case of animal fodder, he suggested that as Khulna has a lot of lowlands, farmers can use floating bed methods to cultivate grass.

Another BARI researcher added that none of the biofortified or genetically engineered crops are being sold in the market as their own brand. They are often mixed with other varieties and sold to the farmers as local varieties. However, if the new varieties can be branded, then the market of researched and biofortified crops may increase and consumer acceptance can improve. He further added that a strong collaboration between DAE, BADC, and research organizations is required.

A representative from the Bangladesh Fisheries Research Institute (BFRI) shared that the feed prices are discouraging farmers from fish farming. BFRI is researching seaweed to develop

better fish feed at a lower cost. BFRI is also conducting vaccine research for carp, tilapia, and prawns, and investigating diseases that are affecting the fisheries sector.

Crab cultivation is another priority in BFRI. Through BFRI's research, the chances of baby crab survival has been raised to 7 percent, which corresponds with the international rate of crab survival technology. These findings have been forwarded to the Department of Fisheries (DoF). He further said that they are encouraging entrepreneurs in crab cultivation. He suggested that crab cultivation should be done indoors via racks, which can also be done by women in their own home. This method will decrease the mortality rate as bacterial attacks will be limited, and farmers only need to invest in the initial settings.

A Senior Scientific Officer in BIRRI identified two main problems in Satkhira: (1) salinity, and (2) waterlogging. To resist salinity, BIRRI had previously released *BIRRI Dhan 67*, and developed *BIRRI Dhan 97, 98, and 99* in October 2020. As a result of this innovation, land that was once only suited to cultivate *BIRRI Dhan 67* due to salinity can cultivate these three varieties.

BIRRI developed the Alternate Wetting and Drying (AWD) method, which lowers the irrigation cost and enhances crop yields. This is an eco-friendly method, which lowers methane emissions—a major contributor to global warming.

A Deputy Director of the Department of Fisheries (DoF) stated that prawns and various types of carp are cultivated in Khulna, Bagerhat, and Satkhira. There are 120,000 prawn cultivators in Khulna, or 200,000 if all fish farmers are considered. For approximately 15 years, vegetables have been cultivated on the shores of fish cultivation ponds, which leaves pesticide residue from vegetables that wash into the ponds and harm the fish. Proper regulations should be maintained with pesticide use to ensure the food safety of fish and vegetable products.

Khulna mostly cultivates shrimps, prawns, mugil, carp, and rui. Now, Khulna's shrimp and prawn production cannot keep up with international demand. Although the use of medicine can enhance production, many export markets reject products with antibiotics residue. While the DoF continues to explore strategies to address these challenges, he suggested that other fish could be explored for their production and export potential, especially mugil and seabass.

Despite advancements in fish technology, many shrimp diseases like White Spot Syndrome Virus (WSSV) and Acute Hepato-Pancreatic Necrosis Disease (AHPND) remain prevalent. Some private companies like Fish tech Limited are establishing laboratories to identify how to address these issues. Furthermore, he advised all stakeholders to stop using antibiotics on fish to improve the fish quality.

A District Fisheries Officer highlighted ongoing fisheries research. In Cox's Bazar, there is ongoing research on seabass cultivation. In Satkhira, researchers found that fish can survive in sweet water. Furthermore, researchers are identifying strategies to address challenges faced by marginal farmers. For example, since marginal farmers have small pieces of land, researchers are concentrating on discovering methods where fish and crops are cultivated together in limited spaces. Most marginal farmers' lands are 1.5 feet below tide level, which makes the pond unsuitable for fish cultivation. The intense sunlight also harms the fish. To cultivate fish, farmers' water must be at least 1 meter deep; thus, further research is needed to identify methods for cultivating fish in shallow waters.

An Upazila Agriculture Officer (UAO) asserted that BARI *Bt Brinjal 1, 2, 3, and 4* are cultivated in Khulna. BARI *Bt Brinjal 4* is especially popular in his area, but once it is exposed to heat, its skin toughens and the quality deteriorates. He observed that many farmers have switched from using pesticides to yellow guards and pheromone traps, which enables safe, organic cultivation. Farmers can benefit from more training on safe fish and vegetable cultivation of fishes and vegetables. The UAO also mentioned that there are safe pesticides available for fish cultivation.

In addition to Bt brinjal, watermelons are gaining popularity in his area, and a farmer even earned BDT 4 lac via watermelon cultivation on the river banks.

The UAO identified key challenges in his area. First, there is a lack of adequate transport in remote areas of Khulna, which is contributing to post-harvest loss of watermelons. Given this, small-scale storage and processing points can be established, which may reduce farmers' losses. Second, although farmers could benefit from training on how to process their crops, necessary resources (e.g., money, other inputs) are needed to utilize this type of training.

He recommended using mechanized harvesters and planters to expedite harvesting Aman paddy as a way to reduce labor costs. Although there is a government subsidized program worth BDT 3,020 crore (\$383.86 million) to provide these machines in Khulna, there are disparities in the distribution of this subsidy across the upazilas.

The cropping pattern in Khulna starts with Aman rice crops, then Boro rice crops, and then the land is vacant. Some farmers cultivate sesame, mungbeans, grasspeas between the production of Aman and Boro crops, or during vacant periods if the Boro paddy is harvested early.

Key challenges include salinity, as well as the lack of proper irrigation, of which the latter hampers Boro production. Aman rice crop relies on rainwater to overcome land salinity and the farmers are trying to replace Boro with *BRR I Dhan 76*. He suggested that if salinity-tolerant and low irrigation crops like maize and mustard can be promoted, then the farmers may benefit.

Zinc rice crops, including *BRR I Dhan 84* and *62*, are becoming more popular, and BADC has sourced 1,000 MT of zinc rice seeds to Khulna this year.

A Senior Upazila Fisheries Officer (SUFO) from Phultala, Khulna provided various constructive insights during the workshop. For instance, he suggested using aerators for shallow water fish cultivation. Also, farmers may be provided biofloc fish cultivation training. He also noted that an integrated platform for fish and crop cultivation should be devised, while providing the necessary training for farmers to ensure sustainable crops and fish cultivation in the coastal areas. There are other areas for potential research, including crab and eel production, and how to improve the quality of fingerlings.

A veterinary surgeon from the Department of Livestock Services (DLS) described the challenges and opportunities in animal cultivation in Khulna. This participant noted that animal production varies by geographic area within the region. For instance, although Dumuria is conducive for raising cattle, Dacope is not due to salinity and low grass growth.

The Department of Livestock Services has been exploring ways to improve inputs for enhancing animal production in different areas. One example is improving grass varieties, which is a crucial input for improving cattle milk production. While natural grass only has 5-6 percent protein, the DLS-promoted Napier grass has 12-15 percent. They are also introducing a new variety of grass called Napier Parchon, which may be cultivated in the vacant lands after the

Aman rice harvest. These grasses are being distributed to farmers so that they can produce their own animal feed. There are no salinity-resistant grass varieties yet. Key challenges include milk storage and marketing. Farmers' access to chill storage can lengthen the shelf-life of milk, reduce waste, and improve farmers' profits. In poultry farming, the egg price sometimes declines, while feed and chick price rises, which harm most poultry farmers as they are relatively small-scale farmers with 2,000-4,000 chickens.

A regulatory committee from the government should monitor the egg prices for poultry farmers. While there has been progress in containing Lumpy Skin Disease (LSD) and Foot and Mouth Disease (FMD), they have yet to eradicate the diseases completely.

Some dealers mislead farmers and recommend the use of antibiotics before the onset of disease or illness for their own profit. This creates health hazards for animals and humans because using antibiotics without reason can build resistance against infections in animals.

An Agricultural Extension Officer (AEO) mentioned that there have been 30 Bt brinjal demonstrations and its yield has been very good this year. On the supply-side, there is relatively low availability of Bt brinjal seeds. Therefore, farmers sometimes face challenges accessing the seeds. On the demand-side, farmers often do not get adequate prices for Bt brinjal because consumers think that the quality of the brinjal is low or it has passed its maturation period due to its hard skin. Decreasing the thickness of Bt brinjal skin could increase its consumer acceptability in the market.

In addition, Bt brinjal would benefit from awareness raising among farmers and consumers about the crop's qualities. For example, for farmers, a major advantage of Bt brinjal is that it is open-pollinated, so farmers can produce the seeds themselves. Among consumers, many are unaware that Bt brinjal is a completely organic crop, without the use of any pesticides. He consumes Bt brinjal himself and confirms that it tastes good. He added that the brinjal could also be eaten in various ways.

According to the AEO, Bt brinjal could gain more popularity if it had more characteristics of local varieties, particularly related to how it looks. In the meantime, workshops and demonstrations are needed to raise more awareness about Bt brinjal.

Land salinity, water stagnation, and late sprouting of crops are places where more research could be helpful.

The AEO shared her observations of zinc rice in the region. Zinc rice has not yet achieved widespread popularity. While some varieties have had challenges, such as *BRRRI Dhan 62*, which is vulnerable to rodent attacks as it ripens too fast, other varieties show promise. For instance, the DAE is planning demonstrations of *BRRRI Dhan 74* and *84* in the Boro cultivation season. *BRRRI Dhan 84* is the one of the best zinc rice varieties: its yield is good, the crop is tall, and its grains produce fine rice alongside producing a good amount of residue, which can be used as animal feed. *BRRRI Dhan 84* is gaining popularity in Khulna; it is currently being cultivated on 100 hectares of land. *BRRRI Dhan 84* also has 10.1 milligrams of iron and 26.6 milligrams of zinc, alongside being a short-duration crop that could be harvested in 140-144 days.

Another UAO chimed in to highlight challenges associated with Bt brinjal production. As other participants have mentioned, there is an insufficiently supply of Bt brinjal seeds to meet farmers'

demand. Although the seed is open-pollinated, there are problems with the size and quality of the produced seed, which is why the DAE is distributing new seeds to the farmers. Nevertheless, Bt brinjal production is a priority, particularly as the government is promoting safe and organic food instead of the regular pesticide-mixed crops.

An Upazila Livestock Officer (ULO) from Batiaghata explained Batiaghata's situation in livestock and poultry farming. The Department of Livestock is trying to assist farmers in formulating feed, and they are promoting grass instead of cow feed, which the farmers can cultivate themselves. He added that they are recommending grass-like Napier grass and Jumbo grass, which have a higher percentage of protein than conventional cow feed. Although Napier grass is not a saline-tolerant variety, it is performing well in Batiaghata, which is a high salinity area. However, the main problem is that Napier grass cannot be cultivated in lowlands. In these cases, farmers can cultivate 'para grass,' which is an aquatic species with slightly lower yield than Napier. Further research on developing grass varieties that are conducive for varying climatic and agronomic conditions should be conducted.

In Batiaghata, the milk price hikes to BDT 40-60 per liter (~\$0.47-0.71) compared with BDT 35 per liter (~\$0.41) in other areas. Proper market linkages are needed to ensure adequate prices for farmers. "We need to raise public awareness of dairy products. The DLS guidelines recommend an average person to consume 250 milligrams of milk daily, but most people do not drink milk."

The new variety of chicken, Multi-Colored Chicken (MCC), has yet to reach Batiaghata. They are currently focused on rearing local chicken breeds, which were neglected before.

The Deputy Research Director of the Agricultural Policy Support Unit (APSU) said that steps must be taken to ensure adequate prices for farmers. Furthermore, cropping intensity must cross 250 percent to enhance agricultural productivity. Lastly, more work is needed to develop and release high-yielding, short-duration varieties, which can be accommodated in the farmers' cropping patterns in different regions of Khulna.

6.2 Perspectives from Agricultural Value Chain Actors

One participant shared that he is a farmer from Dumuria who cultivates *BRR1 Dhan 67*. He yields approximately 1,800 kilograms of rice grain per *Bigha*—nearly double the yield of the previous variety he cultivated, *BRR1 Dhan 28* (approximately 960 kilograms of rice grains per *Bigha*). Although the market price for *BRR1 Dhan 67* is lower than *BRR1 Dhan 28* and the grain is thicker, the production of *BRR1 Dhan 67* is better. "If there is a variety better than *BRR1 Dhan 67*, I will move to that crop," he stated. *BRR1 Dhan 67* is a salinity-tolerant crop that is well-suited for the Khulna region, pointed out to the moderators.

A farmer who grows BARI *Bt Brinjal 4* said that the pesticide cost is lower, the yield is higher, and the size is good. Regarding challenges, the skin becomes a little tough if it comes into contact with summer heat, mites and bacteria can harm it, and the market price of Bt brinjal is almost half when the prices of local variety increase. If the local variety price is low, then there is almost no demand for Bt brinjal.

One farmer shared his experiences cultivating BARI *Bt Brinjal 4* from 2017 to 2019. He noted that he could not sell it in the market because the consumers did not like how it looks. He could only sell the Bt brinjal to the government since the public preferred the local varieties. To

overcome this, he suggested that if the government takes steps in promoting the crop, then the general population might accept it.

A farmer from Dumuria earned BDT 3 lac (~\$3,615) from selling BARI *Bt Brinjal 4*, and reiterated that the crop has high yield. He followed the DAE's instructions and did not face any issues with cultivation and seeds.

Among zinc rice varieties, *BRRRI Dhan 84* is getting popular. However, a farmer complained that due to the grain being a little reddish, he could not properly market the rice. The RDC project is currently providing market linkages to Ali Seed Farm, which is selling *BRRRI Dhan 84*. He stressed that zinc rice varieties should be branded and sold as zinc rice without mixing with other rice varieties.

A farmer from Dumuria added that he is a Piper Chaba tree cultivator and receives calls from abroad to export his produce. Many farmers are adopting Piper Chaba cultivation after hearing his experiences. Currently, there is no research on Piper Chaba trees despite the product being in high demand internationally. This could be a high potential area that warrants further research.

A watermelon farmer from Dumuria said that he is the first to start the watermelon cultivation under a local agricultural officer's advice on 10 *Bigha* of land, which earned him BDT 890,000 (~US\$10,723). The watermelon variety is called 'Pakeeja,' which he sourced from a foreign company called 'Seeders.'

An input dealer requested to extend the cultivation of watermelons as it has proven to be very profitable for the farmers. He attested that there are no problems with the watermelon cultivation and the seeds are available but asked how watermelon cultivation be further increased. One of the moderators stated that BARI has recently developed new varieties of watermelons with both yellow and red flesh which are not released yet but hopefully will reach the farmers soon.

A fish farmer inquired if there is any training available for eel and crab cultivation. A SUFO replied that there was a program featuring that but that has already ended. Finally, the farmer requested Ranajit to restart the training sessions if possible.

A zinc rice farmer asserted that he has been cultivating *BRRRI Dhan 67* for the last three years. The yield is higher than *BRRRI Dhan 28*, less vulnerable to diseases, and is salinity-resistant. As it is an open-pollinated crop, he produces the seeds himself and, according to DAE officials, the seed quality will not diminish in the next three years. He added that he is satisfied with the crop as it is tasty to eat and he gets a good market price for it.

A trader asserted that he buys rice crops from the farmers and sells them to others. Although the zinc rice variety *BRRRI Dhan 67* has better yield and costs less than *BRRRI Dhan 28*, its market price is still lower than *BRRRI Dhan 28*.

An input dealer stated that he is from Dumuria and supplies *BRRRI Dhan67* and *58* in the region. *BRRRI Dhan67* is salinity-resistant and is popular in his area. He suggested to raise awareness on the benefits of producing and consuming zinc rice among farmers and consumers.

An input dealer from Phultola, Khulna has attended training sessions for good cultivation practices. He lives near Dakatia River where farmers cultivate fish and vegetables together. He lamented that the products do not get adequate prices in the market during harvest time.

One participant owns a farm and shared his experiences cultivating a multitude of crops. He uses machinery in farming, which has lowered his labor costs significantly. He purchased this machinery from the agricultural office. He has provided services to other farmers at no cost since the onset of the coronavirus pandemic. He mainly uses the power tiller and crop reaper.

He recommended improved market monitoring of all agro-products since the products go through many middlemen before even reaching the consumers. He also confessed that he has not received any post-harvest training from anywhere and that improved access to this kind of training would benefit many agricultural value chain actors.

Using credit, a poultry farmer purchased poor quality chicks, feed, and even antibiotics from input dealers. The input dealers in his area are connected with the big companies and they even have a committee. He stated that the dealers take the chickens from him and market them at weight-based prices. While this can sometimes benefit him, he mostly faces a loss. If he could finance the chickens himself, then he could profit from poultry.

A representative from Khulna University stated that the southwestern part of Bangladesh only has 139 percent cropping intensity compared with the average cropping intensity of 200 percent in other parts of the country. Furthermore, the drainage system is poor and freshwater is scarce. In the Dacope and Batiaghata areas, only local Aman rice is cultivated, after which the area becomes waterlogged and affected by high salinity. Local Aman rice is a long-duration crop, which often takes until December to harvest. As a result, new crops cannot be cultivated since the farmers are too busy harvesting Aman rice crops. To exacerbate the issue, rodent attacks destroy around 20-30 percent of the produced crops.

To counter these challenges, the participant recommended relay cropping and zero tilling methods, cultivation of short-duration Aman rice, or sowing and harvesting the Aman rice earlier, integrating short-duration and low irrigation crops into the cropping pattern, and community farming. He further added that he has already tested maize, sunflowers, and wheat in Dacope upazila via a zero-tillage method, which was successful. Other nearby farmers are now encouraged to use zero tilling method in their fields.

In the Dacope and Batiaghata areas, fish farming is almost non-existent. Farmers mostly want to return to Boro paddy cultivation, but that requires a large amount of irrigation. Although the rivers' sluice gates are opened in the winter, which releases water into the fields, it is insufficient for Boro rice cultivation. Other than a few short-duration crops, no other crop variety is suited to this region as the land salinity rises after the rice cultivation.

6.3 Perspectives from NGOs, Academia, and Private Sector

A representative from the RDC project implemented by ACDI/VOCA provided various recommendations in response to the discussion. First, single-skinned black sesame has international demand, which could be a research opportunity. He also mentioned that developing a short-duration mungbean variety, where all the pods could be harvested on a single term, could be very beneficial. Furthermore, more attention should be given to developing and releasing high yielding mustard varieties with high oil content. Generally, this region could benefit from the development of climate-resilient, short-duration varieties, with particular attention to submergence-tolerant varieties.

Cattle feed is an essential input for milk production, yet farmers either lack adequate supply of animal feed or do not have high quality feed. To this end, farmers would benefit from being able to produce their own feed rather than purchasing it from private companies.

A representative from CARE Bangladesh asserted that feed technology is important as animal feed represents 60-70 percent of production costs if sourced from outside. Innovative feed technology should be further commercialized as a way to lower feed costs. Furthermore, better monitoring is needed in artificial insemination, especially for the young cattle that carry the semen.

A representative from EnerGaia Corporation Limited asserted that their company is introducing spirulina. They have already started cultivating spirulina in Batiaghata as a trial on 1 *Bigha* of land. After the trial results are out, they plan to source it to the farmers and commercialize the crop. They plan to process spirulina into powder, and further research is underway on other use cases for spirulina.

6.4 Concluding Findings

Key points synthesized from the Khulna workshop are provided below:

- Khulna is characterized by lower cropping intensity and higher land salinity. Further research is needed on how to increase cropping intensity and introduce new crops into the cropping pattern.
- Various participants reiterated the importance of developing, releasing, and promoting short-duration, high yield, and low irrigation crops in Khulna.
- Mechanization is needed to cultivate fish in shallow water as Khulna has a lot of enclosed water bodies. New varieties of fish like seabass, mugil, eel, and crabs also show good potential in Khulna.
- *Bt brinjal-4* has been accepted by the farmers, but there are still complaints from consumers about its hard skin and dull color. Further research on developing a genetically engineered brinjal, which incorporates more qualities of local brinjal varieties, is needed to enhance consumer acceptability.
- Farmers are having different experiences with Bt brinjal: some are unable to market the crop, whereas others are making large profits. Training should be provided to the farmers so that they can cultivate the crop effectively. Many attested local brinjal varieties are preferred more in the market.
- Livestock cultivation is also not doing well due to high salinity. Further research is needed on salinity-resistant grass to function as animal feed in the future.
- Processing and storage facilities for agricultural products to reduce post-harvest losses are required.
- “Ekti Bari Ekti Khamar”-type projects might be helpful in this area.
- BARI is developing two new watermelon varieties with red and yellow flesh, which will be provided to BADC for seed multiplication, and later to DAE for dissemination.
- Biofortified or genetically engineered crops are sold together with the local varieties. Branding is recommended to raise awareness about biofortified and genetically engineered crops.
- *BRR1 Dhan67* is getting popular in Khulna as it is a salinity-tolerant crop.

- Promote the cultivation of Napier and Jumbo grass varieties, which are saline-tolerant and can reduce the costs of livestock feed. As Khulna has mostly lowlands, para grass is also recommended.
- Further research is needed for cultivating fish in shallow water and cultivating fish alongside rice crops.

7 CONCLUSION

USAID organized and IFPRI facilitated five stakeholder consultation workshops on agricultural research and biotechnology in Bangladesh. Upon collating and distilling the findings across the five workshops in this report, it is evident that participants employed varying definitions of 'biotechnology.' Similarly, as the workshops were intended to stimulate dialogue under the auspices of a *stakeholder consultation*, and did not represent a *research seminar*, this enabled participants to share their viewpoints, which were subjective, potentially biased, and, at times, flawed. This report is intended to reflect the discussions as they took place and should be understood by readers when interpreting the content of this report.

With this said, this section summarizes recommendations and ways forward gleaned from the five virtual stakeholder consultation workshops based on the discussions that took place. Upon request from USAID, these summary findings were submitted as a stand-alone deliverable on January 8, 2021.

7.1 Genetically Engineered (GE) Crops and Biotechnology

7.1.1 Status/Challenges

- Government representatives from different ministries and agencies stated that the Government of Bangladesh (GoB) has prioritized agriculture research and development (R&D), and that it has been supporting research on appropriate technologies, including genetically engineered (GE) and gene-edited crop varieties.

Approval process of GE crops in Bangladesh

- Several government officials mentioned that the GoB appreciates the importance of biotechnology and has actively fostered a regulatory environment that can promote biotechnology research.
- There are required approval processes for developing and commercializing GE crops, which do not apply to non-GE crop varieties.
- Research and release of GE varieties is guided by bio-safety regulations, which have been prepared following global bio-safety guidelines. These regulations do not differentiate between homegrown and foreign technologies. The approval process is overseen by the Bangladesh Agricultural Research Council (BARC), the Ministry of Agriculture (MoA) and the Ministry of Environment, Forests and Climate Change (MoEF).
- An Expert Working Group (EWG) harmonizes biosafety guidelines among South Asian countries, and discusses and suggests necessary changes in biosafety guidelines. An MoA representative conceded that the approval procedure for GE crops, such as Bt brinjal and Golden Rice, is lengthy and that a significant amount of time is lost on formal procedures.

Bt Brinjal and Golden Rice

- The Bangladesh Agricultural Research Institute (BARI) has released four varieties of Bt brinjal; while the Bangladesh Rice Research Institute (BIRRI) works towards the release

of Golden Rice, and BARI and other research organizations on other crops (e.g., Bt chickpea, Bt cotton, etc.).

- 3 new Bt brinjal varieties are in the process of obtaining approval from MoEF.
- Based on consumer feedback, BARI has recently developed *BARI 10* and *BARI 11* brinjal varieties, which are resistant to bacterial wilt. They are working on including Bt genes in these varieties.
- BRRI has completed a confined field trial and a biosafety evaluation of Golden Rice and hopes to approve its release soon.

Bt Cotton

- The Cotton Development Board (CDB) is in the process of releasing/approving Bt cotton. They collaborated with the private sector (e.g., Supreme Seed, Lal Teer, and ACI Seeds) on commercializing hybrid cotton varieties, and they believe this partnership is crucial for expediting adoption of new varieties and technologies.

Concerns from Consumer Rights Groups

- Although some rights groups and consumer bodies have been asking for labelling GE crops, it is challenging given the large number of smallholder farmers and small-scale production, and agricultural products such as brinjal are not sold in packaged form.

Taste/size matter for consumer demand

- Just like non-GE crops, taste/size affect consumer perception and demand for GE crops. In some cases, stakeholders reported successful adoption and marketing of Bt brinjal varieties in the consultation districts; in other cases, the six currently released varieties of Bt brinjal did not match local farmer and consumer preferences. Critical feedback included:
 - Some farmers stated that smaller size, dull color, and bitter taste lower consumer acceptance of *Bt Brinjal 1* and *Bt Brinjal 2* varieties.
 - Select farmers stated that it is challenging to sell some of the available Bt brinjal varieties due to the crop hardness compared with softer local varieties.
 - Others mentioned that since available Bt brinjal varieties are long-duration winter varieties, sowing them as early as September might yield better results (e.g., less bitterness). However, this is difficult considering the late Aman rice harvest in Barishal and in some other southern districts.
 - Bacterial wilt attacks in some geographic areas have destroyed harvest and demotivated farmers.

7.1.2 Opportunities

Fostering a Collaborative Approach and Encouraging Private Sector Participation

- The private sector does not yet have the scope to produce genetically engineered varieties.
- There is a need for dedicated scientists for continuing advanced research activities. The GoB should facilitate the effective deployment of these graduates to different research agencies. The GoB should also invest in improving laboratory facilities and establishing linkages with researchers in other countries. The agricultural curriculum should be updated considering current and future priorities.

- A stronger collaboration between various stakeholders – relevant government ministries, government research agencies, universities, private sector actors, etc. – holds paramount importance in research and commercialization of agricultural technologies. There should also be adequate mechanisms to gather and incorporate user/consumer feedback on an ongoing basis.
- Inclusion of Bt genes in popular local brinjal varieties can make them more acceptable and profitable.

Enhancing coordination to improve adoption of GE crops

- More farmers are adopting Bt brinjal varieties, but the process is slow as farmers are hesitant to change their traditional crops. This will be a challenge for Golden Rice as well.
- To expedite this process, dealer networks, the Bangladesh Agricultural Development Corporation (BADC), the Department of Agricultural Extension (DAE) and other relevant stakeholders must improve their coordination and design initiatives that may encourage farmers to adopt these varieties. Relatedly, frequent meetings between large-scale farmers, GoB representatives, dealer networks, and stakeholder organizations were suggested to raise farmers' awareness of the potential benefits of cultivating GE crops. Some participants also mentioned the importance of having small-scale seed providers, dealers, and the DAE playing a more active role in promoting GE crops.

7.2 Non-GMO crops (e.g., rice, oilseeds and pulses, vegetables, etc.)

7.2.1 Status/Challenges

Availability of Stress-tolerant Varieties

- BRRI has released numerous specialized rice varieties that have become popular (submergence-tolerant: *BRRRI-52*; tidal wave-tolerant: *BRRRI Dhan 76*, *BRRRI Dhan 77*; saline-tolerant: *BRRRI Dhan 47*, *BRRRI Dhan 61*, *BRRRI Dhan 67*; Zinc-fortified (Boro rice): *BRRRI Dhan 62*, *BRRRI Dhan 64*, *BRRRI Dhan 72*, *BRRRI Dhan 74*, *BRRRI Dhan 84*).
- Bangladesh Institute of Nuclear Agriculture (BINA) has developed several rice varieties (short-duration: *BINA 7*, *BINA 11*, and *BINA 17*; saline-tolerant: *BINA 10*; submergence-tolerant: *BINA 11*; zinc-fortified: *BINA 20*; other varieties: *BINA 8*)

Specialized research (and commercialization of agricultural research products) depending on the specific climatic conditions of different regions is required:

- Northern and southern Bangladesh has very different soil and climatic conditions. For example, Jhalakathi has large canopies formed by trees, which makes rice cultivation difficult. In Barishal and some other southern districts, a large portion of the total cultivable areas remains under 1-3 feet water for 3-4 months annually. During summer months, irrigation becomes a challenge, as most of the land is clay soil and irrigation infrastructure/ system is underdeveloped.

As it is not possible to increase total land under cultivation, Bangladesh may focus on the following:

- Increase cropping intensity, crop diversification, and high-value crop cultivation.
- Develop and improve the adoption of appropriate varieties (e.g., short-duration, high-yielding, and high-value crop varieties) with characteristics to sustain in changing climatic conditions (and in particular, to higher incidence of draught, salinity, heat, cold, rain, etc.) and to tolerate diseases and infestations.
 - In Barishal, for example, the need for promoting early cultivable and short-duration Aman rice varieties was discussed, as well as short-duration oilseeds (e.g., mustard) and pulses (e.g., mungbean) varieties to increase cropping intensity. Watermelon is also a high-potential (and high-value) crop for this area.
- Focus on the development and commercialization of frontier technologies.
- Disseminate conservation agriculture practices, such as zero tillage, use of seeders and transplanters to save time.
- Improve processing and storage facilities for value-addition and guaranteeing higher return for everyone involved.
 - Incentivize farmers to adopt new varieties and technologies (through monetary and non-monetary means).

There must be more focus on increasing mechanization to reduce the cultivation turnaround time and to deal with agricultural labor shortages.

- Bangladesh has largely mechanized land preparation and irrigation. Despite ongoing research and availability of some of the machineries, little is currently used for sowing, planting, harvesting, and drying operations, which are mostly done manually. There is more to be done to achieve user acceptance.
- Moreover, local agri-machinery companies engaged in assembling are finding it difficult to compete with imported machineries due to higher duty on machine parts and lower duty on imported machineries. The market size is small, and it does not justify private investment in R&D. The GoB should facilitate stronger collaboration between research agencies and the private sector and support the opening up of export opportunities.

7.2.2 Opportunities

- Research should focus on crop zoning, i.e., identifying potential cultivation areas and suitable crops. For example, cropping intensity could be increased in southern Bangladesh, where currently 1-2 crops are cultivated.
- Varieties and technology development should consider climate change and customer demand. Unless these factors are considered, farmers profitability and adoption of the varieties and technologies cannot be guaranteed. More targeted research activities, including frontier technologies, should be undertaken based on national and regional priorities.
- Considering local cropping pattern and preferred crops, research could focus on developing the following varieties, with or without use of genetic engineering:
 - Rice - drought-tolerant Aus rice variety; dwarf aromatic rice variety (avoid lodging); submergence-tolerant variety
 - Wheat - blast-resistant variety
 - Maize - resistant to fall armyworm
 - Potato - blight-resistant variety
 - Brinjal - bacterial wilt resistant
 - Tomato - resistant to leaf curl virus
 - Lentil - short-duration and resistant to fruit and root rot
 - Mungbean - one-time pod picking like black gram

- Chickpea - resistant to pod borer
 - Mustard - variety with higher oil content
 - Sesame - variety with higher oil content (single-skin)
 - Flower - varieties of different color, increased shelf life
- Promote non-rice crops during the Boro season in districts that are not suitable for Boro rice cultivation.
 - Expand zero tillage cultivation practices and relevant crops (e.g., potato, garlic, wheat, maize, sunflower, etc.)
 - Promote expansion of drip irrigation-based cultivation practices and relevant crops (e.g., pumpkin, watermelon, etc.)
 - Develop salinity and pod-borer-resistant mungbean varieties, and use high-speed rotary power-tillers to expand mungbean cultivation.

7.3 Livestock and Poultry

7.3.1 Status/Challenges

- Dairy farmers are facing challenges due to increasing feed and fodder prices and reduced demand for milk (stemming from the COVID crisis). Small farmers cannot produce high quality milk and dairy products due to lack of knowledge and quality feed ingredients.
- Livestock production is closely related with agriculture as people use grains/ seeds for human consumption and the plant residue for animal consumption. The development of dwarf rice varieties and mechanization is reducing straw outputs, while excessive use of pesticides for crop protection is creating some animal health hazards.
- In Jashore, the Department of Livestock Services (DLS) is working closely with the dairy association to ensure delivery of quality artificial insemination (AI) services at a minimum cost.
- Inbreeding is a major challenge for AI-based breed development as there are no records of existing breeds and on the ongoing AI activities. Sometimes farmers seek a particular breed without assessing their capacity to rear it.
- The livestock sector in some districts such as Khulna is less developed than in other parts of the country. Salinity is the main challenge for grass/ fodder cultivation, and in turn, for the expansion of cattle, goat, and sheep rearing.
- Milk marketing is a challenge as there are no chilling/large-scale processing facilities. Farmers are dependent on local sweet/sweetmeat shops, which have limited demand.
- Small-scale poultry farms depend on dealers for securing raw materials on credit; thus, they are often influenced to apply antibiotics as a precaution rather than treatment. This is creating serious human health hazards.
- Disease diagnosis and treatment remains a challenge. Foot and mouth disease (FMD) for cattle and avian influenza for poultry are common but they seem to be under control.

7.3.2 Opportunities

- Extension workers and livestock service providers may educate small farmers on feed production so that they can collect locally available ingredients and produce a balanced feed.
- Research should consider the impact of introducing new varieties and technologies on animal consumption. Biotechnology could be used to reduce application of harmful medicines to control animal diseases.
- Develop saline-tolerant grass varieties in salinity-affected districts like Khulna, as it is not feasible to increase milk production without grass.
- Establish local chilling/milk processing facilities, which may encourage farmers to expand dairy farming.
- Improve regulation of feed prices and increase access to finance in support of small-scale poultry farms.

7.4 Fisheries

7.4.1 Status/Challenges

- Fisheries research has mostly focused on fish culture and breed development, without using biotechnology.
- Bangladesh Fisheries Research Institute (BFRI) and the USAID-funded Bangladesh Aquaculture Activity are working on improving the productivity of local Rui (carp) species (up to 1.2 kg growth per year) by cross-breeding it with Indian carp species (up to 2-3 kg growth per year). They are hoping to increase its growth up to 2.2 kg per year.
- Currently, Pituitary Gland (PG), a critical component for fish breeding, is imported from India. Price of PG increased from BDT 2-3 to BDT 100 (~\$0.00-1.18) during COVID, significantly increasing the cost of production.
- Use of ready-feed and medicines have contributed to increasing productivity but excessive use is also creating health hazards. The Department of Fisheries (DoF) and the private sector should work together for quality assurance of feed and medicines available in the market, and to promote appropriate use.
- Disease diagnosis remains a major challenge. Some companies are setting up labs in the region, which may improve diagnosis and treatment.
- Dry fish production is a major activity in Cox's Bazar. Every year, 10,000 MT of dry fish is produced in the district and supplied to various parts of the country. However, small processors use harmful insecticides during drying and storage of dry fish. This is creating huge food safety challenges and causing deadly diseases. As the processors want to keep the costs down, they are not keen on using practices recommended by BFRI/DoF.

7.4.2 Opportunities

Inputs (PG, Feed, Medicines)

- Educate fish farmers and processors in retail markets on how to extract, preserve, and supply PG, which can improve local PG supply if scaled up properly.
- Expand adoption of technologies like fish milt preservation, which can increase the shelf-life of fish. Fish milt could be transferred from one district to another district and can reduce chances of inbreeding.
- Conduct research on feed diversification and small-scale feed production using locally available feed ingredients to reduce costs and improve profitability of small farmers.

Species Development

- Develop different species of shrimp and prawn for export market.
- Develop and expand sea bass and mugil, as these species have global market demand (BFRI is working for sweet-water adoption of these varieties).
- Expand crab and eel farming, targeting the export market.

Production

- Integrate fish and vegetable farming following good agricultural practices (GAP)
 - Research may focus on promoting integrated farming practices (e.g., combining fish farming with duck rearing) in ponds and low-land areas, as it can reduce fish feeding costs and increase aeration naturally.
- Use mechanized aerators for fish cultivation in shallow water bodies.
- Expand biofloc technology for fish farming.
- Ensure quality of output of carp nurseries.

Processing/Marketing

- Conduct research on developing appropriate technologies for fish processing, drying, storage, and packaging.
- Identify feasible mechanical dryers to extend drying hours during monsoon, especially in Cox's Bazar district.
- Conduct market research to identify more attractive, lucrative markets

APPENDIX 1: INVITATION



The U.S. Government's Global Hunger & Food Security Initiative

Dear Participant,

I am delighted to invite you to attend a virtual workshop on Agricultural Research and Biotechnology, organized by USAID and facilitated by IFPRI. The virtual workshop for Barishal will be held on December 6, 2020 from 9:30-11:30 a.m. using Zoom. Please see the joining information below:

Zoom link: www.tinyurl.com/session-6DEC2020

The purpose of this workshop is to learn from relevant stakeholders about the challenges, opportunities, and recommendations related to Agricultural Research and Biotechnology. Your inputs will be valuable for this workshop. We have also sent a calendar invite following this e-mail with the same information.

To join the Zoom workshop, we recommend that you participate in a location with good internet connectivity. Our team will contact you before the workshop to remind you of the event date and provide other details.

Thank you and we very much hope that you will accept our invitation.

Best regards,
M. Mehrab Bakhtiar
IFPRI Country Representative for Bangladesh (Acting)





The U.S. Government's Global Hunger & Food Security Initiative

সম্মানিত অতিথি,

ইউএসএআইডি (USAID) আয়োজিত এবং ইন্টারন্যাশনাল ফুড পলিসি রিসার্চ ইন্সটিটিউট (IFPRI) সম্বলিত কৃষি গবেষণা এবং জীব প্রযুক্তি শীর্ষক ভার্সুয়াল কর্মশালাতে অংশ নেওয়ার জন্য আপনাকে আমন্ত্রণ জানাতে পেরে আমরা আনন্দিত। এই ভার্সুয়াল কর্মশালাটি বরিশালের জন্য অনুষ্ঠিত হবে আগামী ৬ ডিসেম্বর, ২০২০ সকাল ৯.৩০টা থেকে ১১.৩০ টা পর্যন্ত জুম (Zoom) অনলাইন প্রাটিকর্মে। জুম মিটিং এ যোগ দেয়ার জন্য প্রয়োজনীয় তথ্য নিচে দেয়া হল।

জুম মিটিং লিঙ্ক: www.tinyurl.com/session-6DEC2020

এই কর্মশালার উদ্দেশ্য হল, কৃষি গবেষণা এবং জীব প্রযুক্তি (Agricultural Research and Biotechnology) বিষয়ক চ্যালেঞ্জ, সুযোগ-সুবিধা এবং সুপারিশসমূহ জানা। এই বিষয়ে আপনার মতামত অত্যন্ত মূল্যবান।

জুম কর্মশালাতে যোগদানের জন্য আমরা পরামর্শ দেব যে, আপনি এমন একটি স্থান থেকে অংশগ্রহণ করবেন যেখানে ইন্টারনেট নেটওয়ার্ক ভালো। কর্মশালা শুরু আগে আমাদের দল আপনাকে কর্মশালাতে যোগদানের জন্য প্রয়োজনীয় সমস্ত তথ্য সরবরাহ করবে।

আপনাকে অসংখ্য ধন্যবাদ এবং আমরা আশা করছি যে, আপনি আমাদের আমন্ত্রণ গ্রহণ করবেন।

শুভেচ্ছান্তে,
এম মেহরাব বখতিয়ার
IFPRI বাংলাদেশ কান্ট্রি রিপ্রেজেন্টেটিভ (ভারপ্রাপ্ত)



APPENDIX 2: PROGRAM



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Program

Time	Topics
9:20 9:35	Introduction to Zoom Functionalities
9:35 9:39	Welcome/Introductory Remarks from IFPRI and USAID
9:39 9:44	Overview Presentation & Objectives of the Consultation
9:44 11:20	Breakout Sessions: Discussion with Stakeholders
11.20 11.25	Return to main session and discussion
11:25 11:30	Concluding Remarks





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অনুষ্ঠান সূচী

সময়	বিষয়
৯:২০ ৯:৩৫	জুম কার্যক্রমের পরিচিতি
৯:৩৫ ৯:৩৯	IFPRI এবং USAID থেকে অভ্যর্থনা বক্তব্য
৯:৩৯ ৯:৪৪	সংক্ষিপ্ত প্রেজেন্টেশন এবং আলোচনার উদ্দেশ্য
৯:৪৪ ১১:২০	ব্লক আউট সেশন: স্টেকহোল্ডারদের সাথে আলোচনা
১১:২০ ১১:২৫	মূল সেশনে প্রত্যাবর্তন এবং আলোচনা
১১:২৫ ১১:৩০	সমাপ্তিসূচক বক্তব্য


